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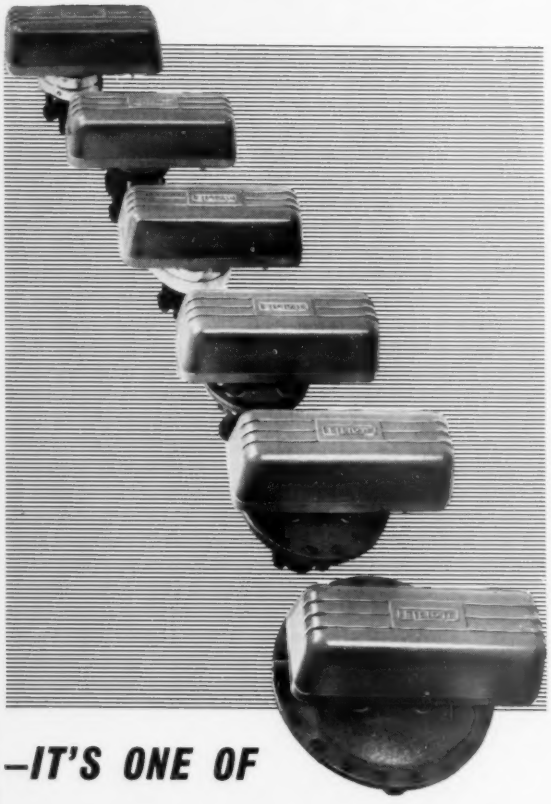

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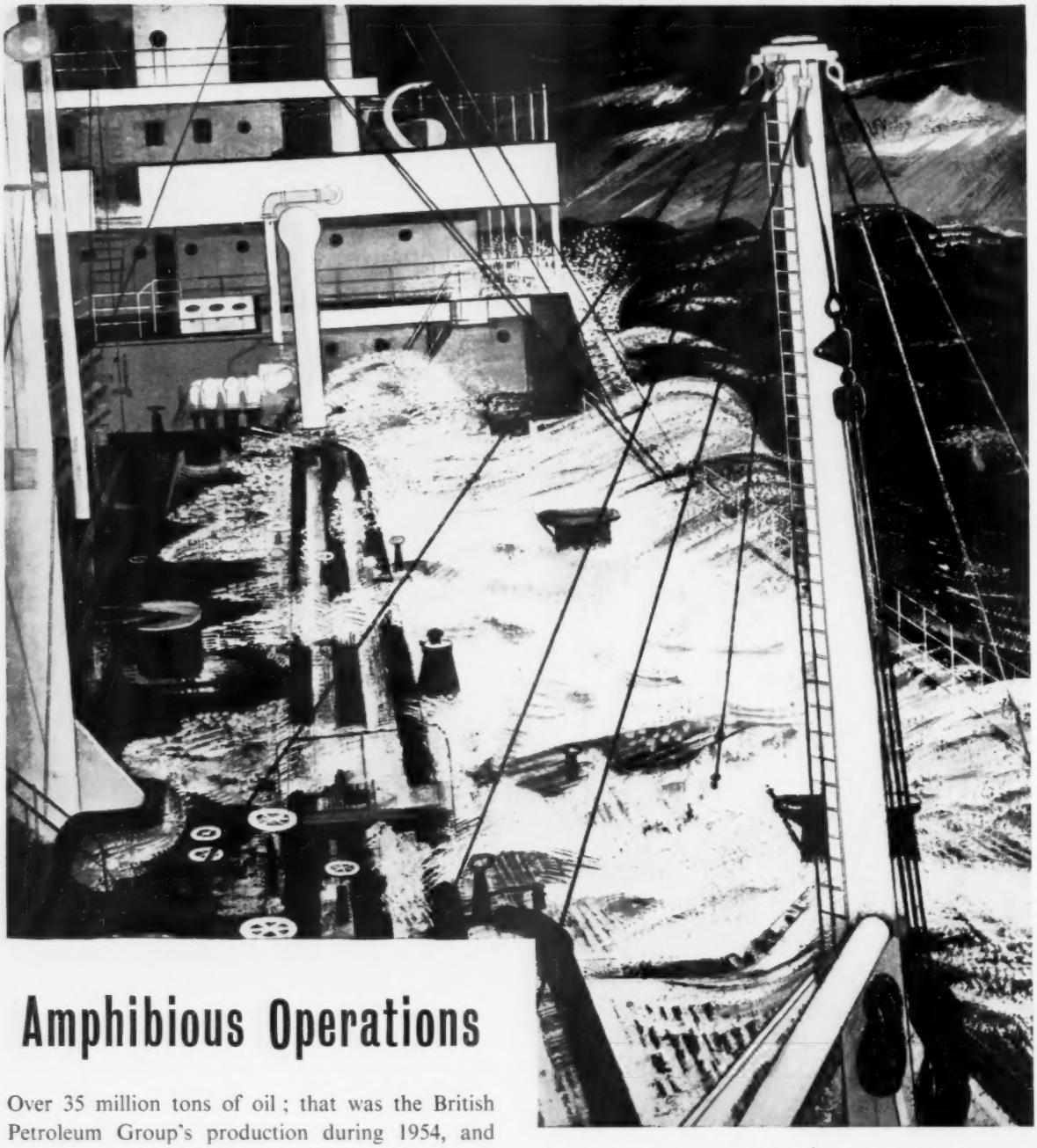

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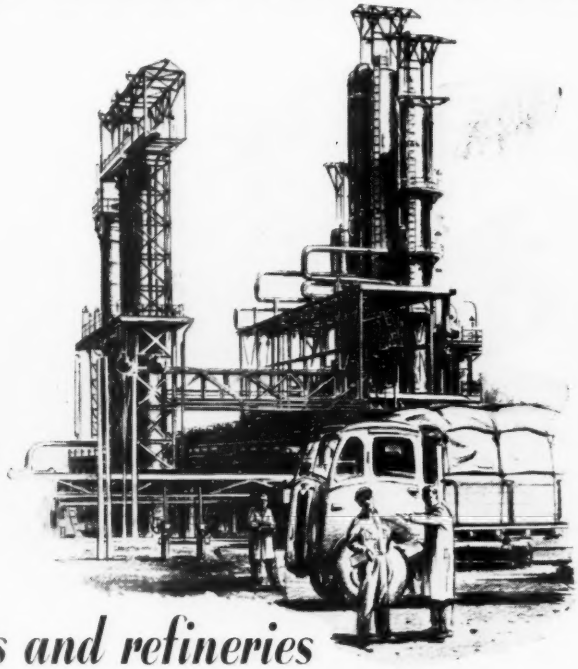

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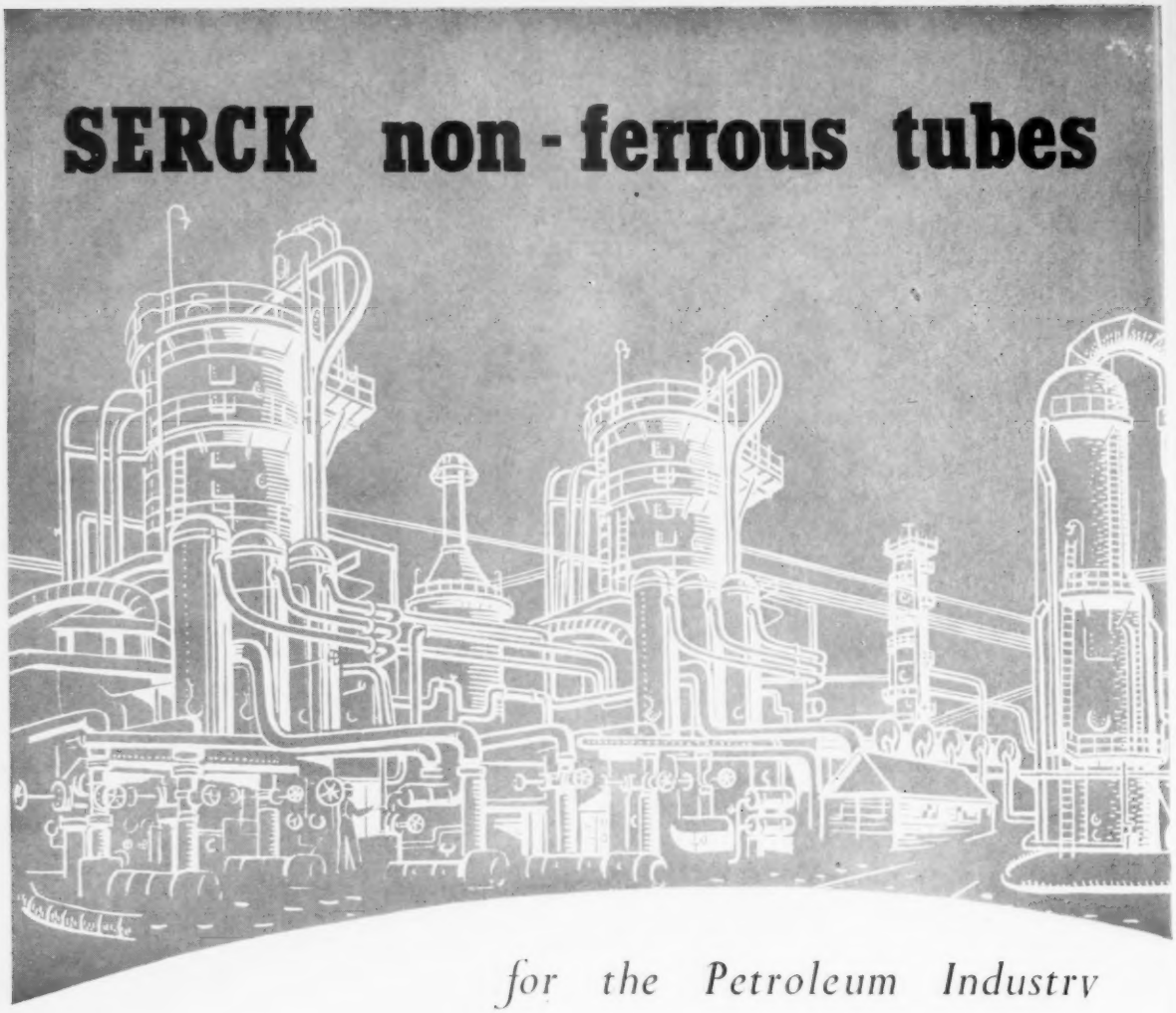

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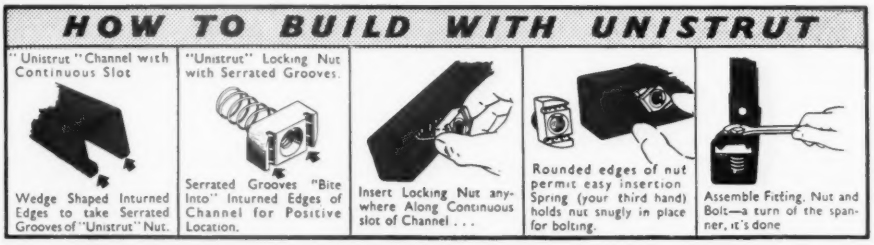
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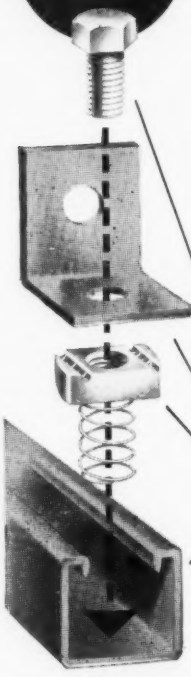

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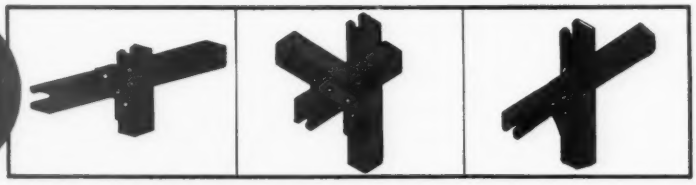

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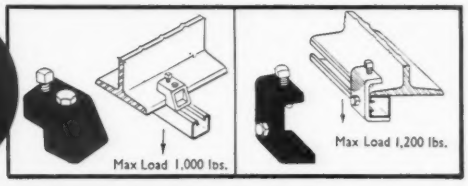

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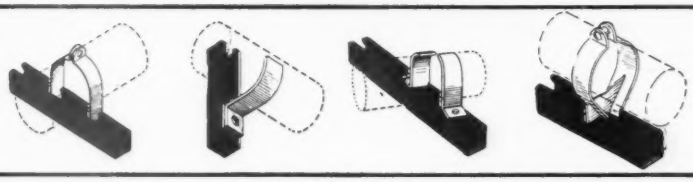

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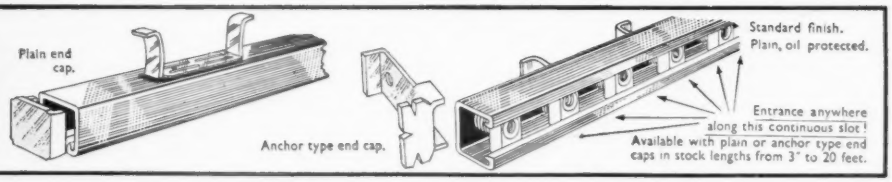
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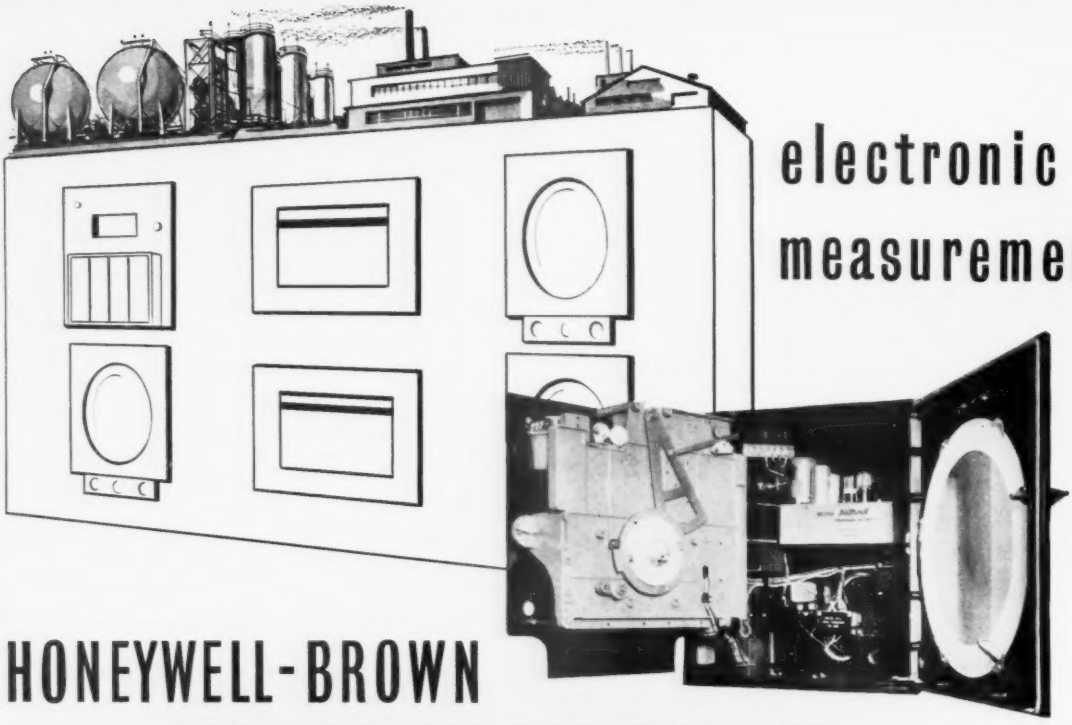

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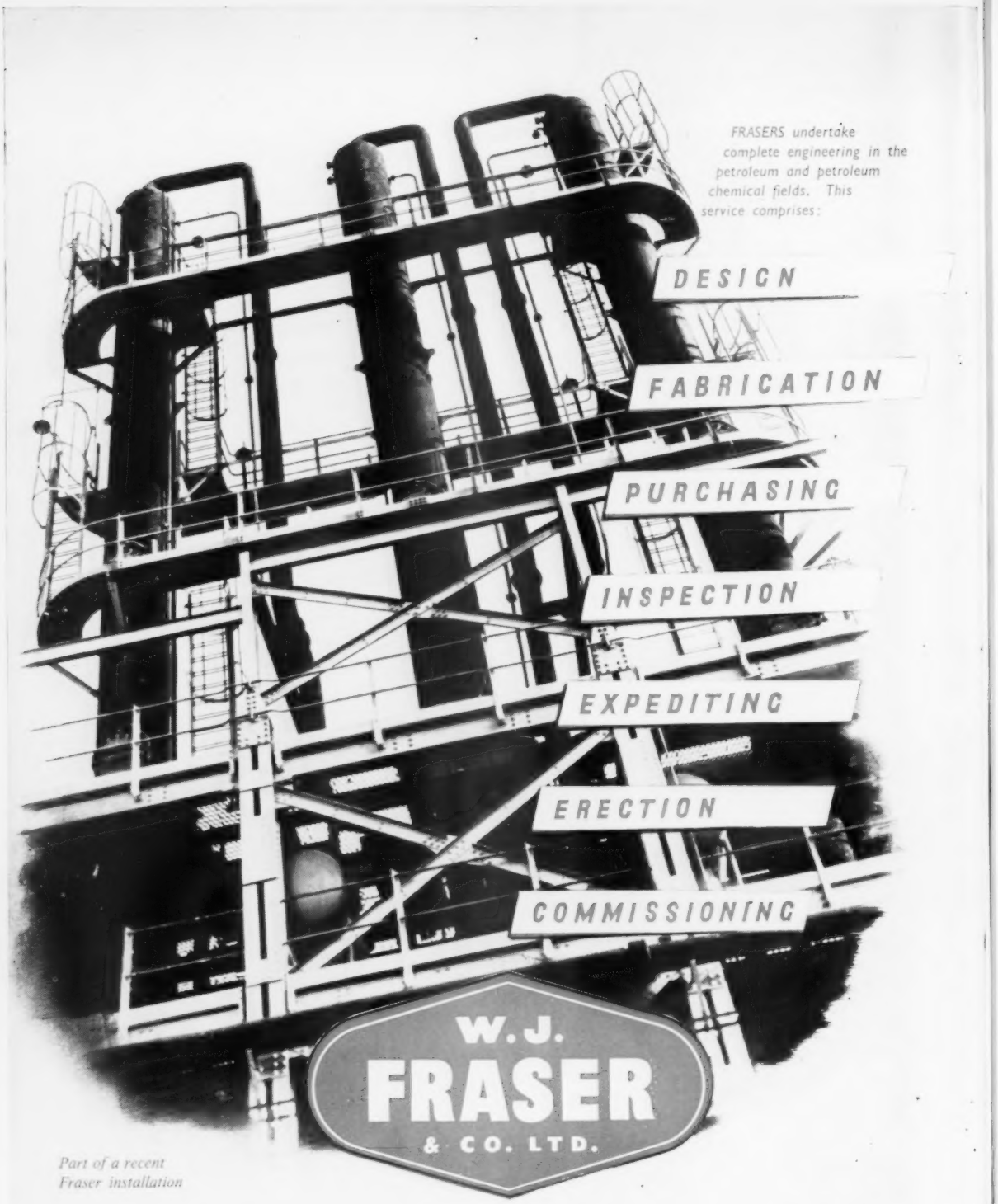

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The Mass Spectrometer in Refinery Control

By D. CROWE*

Introduction

Twelve years have elapsed since the analytical mass spectrometer was first introduced into a refinery laboratory. During this period more than one hundred mass spectrometers have been bought by oil and chemical companies throughout the world and the instrument has become the accepted first choice of the industry whenever large numbers of multi-component gas analyses are required. The reasons for this choice of a relatively expensive and complicated instrument by a cost-conscious and competitive industry can be found in the high work load and the correspondingly rapid pay-back time of the mass spectrometer and the accuracy, reliability, and speed of the method.

During this period the applications of the instrument outside the gas analysis range have also been abundantly demonstrated. A small number of mass spectrometers in research laboratories are now engaged on analytical work throughout the gas to petroleum wax range of materials. In addition, a very small number of mass spectrometers have been installed in refinery panel rooms and used for the automatic continual sampling and analysis of the contents of plant streams.

Within the limited confines of one article the author has attempted to give a general survey of the contribution which the mass spectrometer has made to refinery control, and of its future possible applications. In order to help to explain the ability of the instrument to analyse complex and diverse multi-component mixtures, a brief description of the operation of the spectrometer and the way mass spectra are produced has been included.

Principle of Operation

The mass spectrometer, which is shown in schematic form in Fig 1, can be used for the analysis of gases or volatile liquids. Samples consisting of 1 ml of gas at N.T.P. or 0·005 ml of liquid are completely vaporized into an evacuated reservoir R in which the pressure (after the introduction) is of the order of 0·1 mm Hg.

From this reservoir, the sample molecules effuse at a constant rate through a capillary leak into the ionization chamber.

Here the electrically neutral gas molecules are bombarded by a narrow beam of electrons emitted from a heated tungsten filament. The ionization and dissociation processes which take place within the ion chamber are described more fully in the next section. Let it suffice to say here that in the case of hydrocarbon molecules, ions of a wide mass (m) range are formed, each ion carrying an electrostatic charge (q) due to the capture or loss of one or more electrons. In general, negatively charged ions are less abundant and they have been used only in limited analytical applications. The loss of more than one electron is also a very improbable process and therefore in the following simplified description it will be assumed that all ions carry a unit positive charge.

These ions are accelerated out of the ion chamber by an intense electric field and collimated into a very narrow beam by a series of slits located in the ion gun region of the spectrometer. This beam of mono-energetic ions is directed into a uniform magnetic field wherein the ions, acted on by a transverse electromagnetic force, are thereby constrained to follow circular paths, the radii of which are dependent upon the individual ion velocities and therefore upon their individual masses. All ions of the same mass follow paths of the same radius, the lighter ions being more strongly deflected than the heavy ones.

By gradually increasing the magnetic field, ion beams of successively greater mass are focused in turn on an exit slit behind which is located a collector electrode. For any one value of magnetic field, the electric current imparted to the collector is proportional to the concentration of ions of this

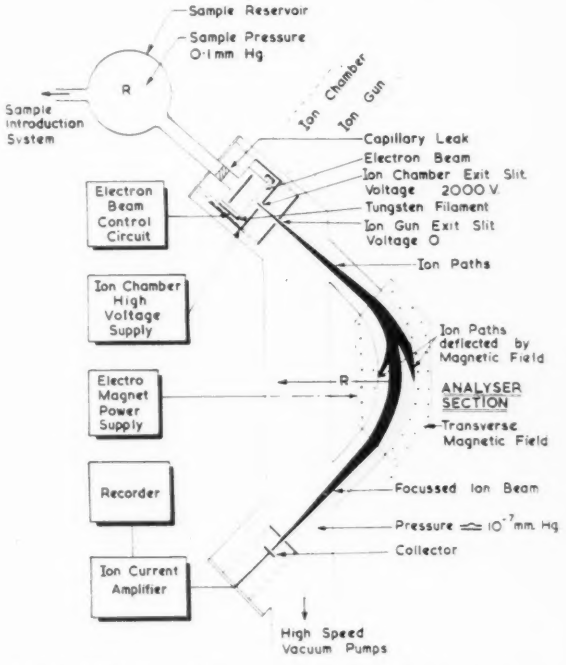

Fig 1. *Schematic diagram of* 90° *ion deflection type mass spectrometer.*

corresponding mass in the ionization chamber. The collector current is amplified and fed into a recorder which produces a trace, the abscissa being proportional to the continuously varied magnetic field (which in turn is a measure of the ion mass) and the ordinate being proportional to the ion concentration. This trace is called a mass spectrum.

Ionization and Dissociation by Electron Impact

When one of the bombarding electrons approaches sufficiently close to a molecule for the electric fields to interact, in the resulting energy exchange the molecule may absorb sufficient energy to emit an electron. The molecule is then said to be ionized.

The molecules which are not ionized play no further part in the operation of the spectrometer. They effuse out of the ion chamber and, unaffected by the electric and magnetic

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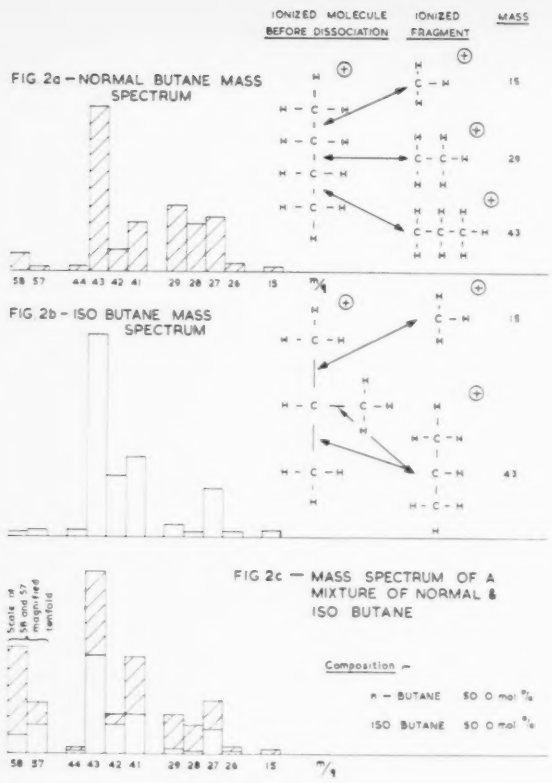
IONIZED MOLECULE BEFORE DISSOCIATION
IONIZED FRAGMENT
MASS
FIG 2a – NORMAL BUTANE MASS SPECTRUM
58 57 44 43 42 41 29 28 27 26 15 m/e
FIG 2b – ISO BUTANE MASS SPECTRUM
FIG 2c — MASS SPECTRUM OF A MIXTURE OF NORMAL & ISO BUTANE
Scale at 58 and 57 magnified twofold
Composition –
n – BUTANE 50·0 mol %
ISO BUTANE 50·0 mol %
58 57 44 43 42 41 29 28 27 26 15 m/e

Fig 2.

fields, they are finally pumped out of the analyser tube by high speed diffusion pumps. Due to the pressure differential maintained by these diffusion pumps between the spectrometer reservoir and the analyser tube, the gas sample in the ion chamber is being continuously replenished from the reservoir.

As a further consequence of the energy imparted to the molecule from the bombarding electron, the ionized molecule may dissociate into a charged particle and a free radical. Only the charged fragment, however, responds to the electric and magnetic fields, being accelerated out of the ion chamber and deflected towards the collector in the manner previously described.

This process may be more clearly represented by reference to the mass spectrum of *n*-butane in Fig 2a wherein the intensities of the major ions are shown in schematic form. It will be noted that ionized fragments resulting from the dissociation of all the possible combinations of the molecular bonds have been detected and their intensities measured by the mass spectrometer. The intensities of these fragments are directly proportional to the partial pressure of the *n*-C_4 molecules in the ionization chamber and thence to the partial pressure of *n*-C_4 in the mass spectrometer reservoir. For any given set of instrumental conditions these intensities (when referred to a standard vapour pressure in the mass spectrometer reservoir) are constant over many months of operation.

In Fig 2b the mass spectrum of *iso*butane is shown in schematic form. It is apparent that although both *n*- and *iso*-butane ion fragments appear at the same masses, their relative intensities at certain masses are widely different. A mixture of *n*- and *iso*-butane can therefore be analysed by the mass spectrometer with high accuracy by comparing the ion intensities at two different masses of the mixture mass spectrum, Fig 2c, with the ion intensities at the same masses for the two pure compounds. The computation devolves into the solution of two linear simultaneous equations; the two unknowns being the required partial pressures of *n*- and *iso*-butane.

Mass Spectral Analysis of Multi-component Mixtures

It has been shown above how a mass spectrum is produced. It should be emphasized that the mass spectrum of a pure compound, depending as it does upon the atomic masses and the atomic arrangement within the molecule, usually provides a unique identification of that compound. This identification is usually less equivocal than that derived from other physical properties such as boiling point, density, refractive index, and ultra-violet and infra-red spectra.

A mass spectral analysis is carried out by comparing the mass spectrum of an unknown mixture with the mass spectra of the pure compounds which have been qualitatively detected or suspected from an examination of the mixture mass spectrum.

This comparison and the subsequent calculations can be rapidly carried out by computing staff using electrical hand calculating machines. In some large American refineries the routine calculating work is now carried out by semi-automatic punched card machines or by electronic digital computers. These machines are capable of carrying the computational load of several mass spectrometers, but their cost is correspondingly high and they are difficult to justify for a small mass spectrometry laboratory. Considerable economies have been effected by their use in large installations or where they have been used for additional work, *e.g.* pay-roll and product blending computations and plant design and technological calculations.

The method of computing has already been illustrated in the case of an nC_4–iC_4 mixture. The composition of a slightly simplified cat cracker dry gas sample is shown in Fig 3 in which the mass spectrum of the sample is compared with the mass spectra of the pure constituents.

Routine Gas Analysis—Inorganic Gases and C_1–C_5 Hydrocarbons

(a) General Scope and Speed of Analysis

Samples containing up to 20 components in this range are regularly analysed in mass-spectrometry laboratories. The components which would be resolved and quantitatively estimated are listed in Table 1. The mass spectrum of a mixture containing H_2, N_2, O_2, CO_2, C_1–C_5 hydrocarbons would be obtained within 20 minutes of receiving the sample

TABLE I

COMPONENTS RESOLVED BY THE MASS SPECTROMETER IN THE INORGANIC GAS, AND C_1-C_5 HYDROCARBON RANGE

Hydrogen	Methane
Nitrogen*	Ethane
Carbon monoxide*	Ethylene
Nitrogen+CO	Acetylene*
Oxygen	Propane
Carbon dioxide	Propylene
Rare gases	*n*-Butane
	*iso*Butane
	1-Butylene*
	2-Butylene* (*cis* and *trans*)
	*iso*Butylene*
	Total butylenes
	Butadiene
	n-Pentane
	*iso*Pentane
	Total Pentylenes
	Pentadiene
	*Cyclo*pentane*

*These components can be accurately resolved only in restricted circumstances

and the computation in terms of mol per cent or wt per cent completed within a further 30 minutes.

By comparison, an analysis of an ethane–ethylene splitting column sample containing C_1, C_2, C_2'', and C_3'' would be completed within 20 minutes.

A typical hydrocarbon gas separation unit is diagrammatically illustrated in Fig 4. Table II gives information as to the detectability limit of the trace compounds (in which interest is mainly centred), the accuracy of the estimation of each compound, and the time required for each mass spectral analysis.

The above time estimates, and the costing estimates in terms of man hours per sample quoted in section (*c*) have been based on the assumption that only electrical hand calculating machines are available for computational work.

(*b*) *Throughput of Analyses*

It is difficult to generalize about the rate at which samples can be run through a mass spectrometer. This throughput is dependent upon the number of components in the sample, the type of sample, the accuracy required, the method of recording the mass spectrum, and the design of the sample handling introduction system. For the average refinery gas sample schedule, 20 samples per 8 hour day represents a satisfactory figure. On this basis of 20 samples per 8 hour

TABLE II

MASS SPECTROMETER ANALYSES OF HYDROCARBON GAS SEPARATION PLANT STREAMS

Stream	*Major components*	*Trace components*	*Average composition mol %*	*Limit of detectability mol %*	*Maximum Error ± mol %*	*Time for result, min*
(i) Demethanizer tops . . .	C_1		25·0		1·0*	
	H_2		65·0		1·0*	20
		C_2''	7·0	0·05	0·1	
		C_2	3·0	0·05	0·1	
(ii) De-ethanizer tops . . .	C_2		45·0		1·0*	
	C_2''		45·0		1·0*	
		C_1	4·0	0·05	0·2	20
		C_3''	4·0	0·05	0·1	
		C_3	2·0	0·1	0·1	
(iii) Depropanizer tops . . .	C_3		45·0		1·0*	
	C_3''		45·0		1·0*	20
		C_4	5·0	0·1	0·2	
		C_4''	5·0	0·1	0·2	
(iv) Ethylene splitter tops . .	C_2''		90·0		0·3	
		C_1	5·0	0·05	0·2	15
		C_2	5·0	0·05	0·1	

*These components are not required to very high accuracy. The error can be halved by more frequent calibration.

day, it will be seen that one mass spectrometer will carry the same load as six or more low temperature distillation columns.

Outputs of up to 40 samples per 8 hour day have been reported from American laboratories using high speed photographic recorders. It should be pointed out, however, that even with these high throughputs an average of one man hour was required per analysis when the overheads were pro-rated into the cost of each analysis.

(*c*) *Cost of Analyses—Average Number of Man-Hours per Sample*

For the average refinery type of sample which ranges in complexity between the 20-component and the 4-component samples cited in section (*a*), and pro-rating the time spent on calibration of the spectrometer with pure compounds, the

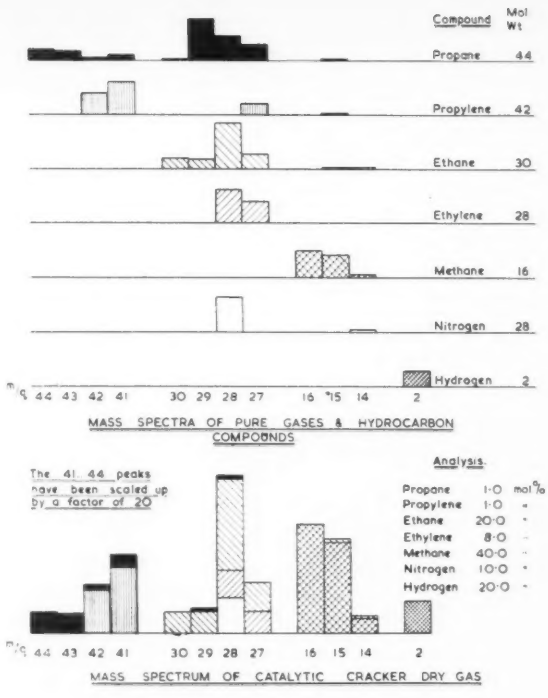
Compound
Mol Wt
Propane 44
Propylene 42
Ethane 30
Ethylene 28
Methane 16
Nitrogen 28
Hydrogen 2
m/e 44 43 42 41 30 29 28 27 16 15 14 2
MASS SPECTRA OF PURE GASES & HYDROCARBON COMPOUNDS
The 41, 44 peaks have been scaled up by a factor of 20
Analysis
Propane 1·0 mol%
Propylene 1·0 "
Ethane 20·0 "
Ethylene 8·0 "
Methane 40·0 "
Nitrogen 10·0 "
Hydrogen 20·0 "
m/e 44 43 42 41 30 29 28 27 16 15 14 2
MASS SPECTRUM OF CATALYTIC CRACKER DRY GAS

Fig 3.

preparation of calibration data, the analysis of synthetic mixtures to check the accuracy of the spectrometer, instrument and sample bomb maintenance, reporting and checking of results, and general laboratory routine, etc., it has been found that one to two man hours are required per analysis.

(*d*) *Accuracy*

The instrument requires only 1 ml of gas at N.T.P. for an analysis and therefore blends of accurately known composition (maximum error = 0·1 mol per cent) made from the highly purified (and therefore expensive) components are regularly analysed. This ability to check easily and absolutely the accuracy of the instrument for any mixture composition is one of the greatest advantages of the mass spectrometer.

It is impossible to quote a general figure of accuracy for mass spectral analyses of refinery C_1–C_5 samples, for this depends upon the component under consideration and the composition of the rest of the mixture. A long standing estimate of ±0·7 per cent maximum error (expressed as a percentage of the total sample) for paraffins and O_2, and ±1·0

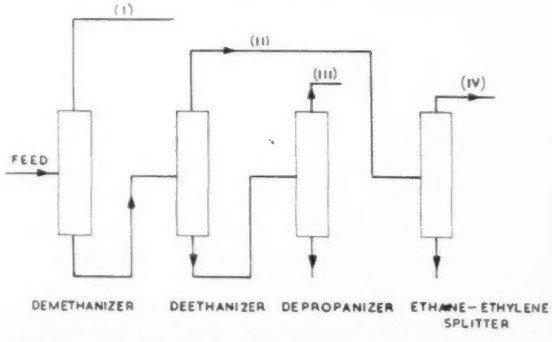

Fig 4. *Flow diagram of hydrocarbon gas separation plant. (Details of mass spectral analyses—Table II.)*

per cent for olefins, H_2, N_2, is an approximate guide and refers to a multi-component analysis which would be completed within one hour. These accuracy figures refer to major components. For minor components the accuracy can usually be considerably improved (Table II).

The average accuracy of analysis of a synthetic mixture under routine refinery laboratory conditions is indicated in Table IIIA. Twenty-four analyses of a H_2 N_2 CO_2 C_1–C_4 hydrocarbon synthetic blend of a composition specifically chosen to magnify mass spectrometer inaccuracies were carried out at Stanlow Refinery on a Metropolitan Vickers Type M.S.2 instrument over a nine-months period. During this time only the calibration of the mass spectrometer for hydrogen was changed and no precautions were taken to obtain better than average accuracy. The average error of 0·15 mol per cent per component (expressed as a percentage of the total sample) with an average standard deviation of 0·33 per cent represents a satisfactory accuracy for the majority of refinery requirements and indicates that the

TABLE IIIA

AVERAGE ACCURACY OF A REFINERY MASS SPECTROMETER
24 ANALYSES OF A $H_2N_2CO_2C_1$–C_4 BLEND OVER A 9-MONTH PERIOD

Component	*Synthetic composition mol %*	*Average error of M.S. determinations mol %*	*Standard dev. of M.S. determinations mol %*
Hydrogen . . .	10·0	+0·11	0·48
Nitrogen . . .	10·0	+0·30	0·43
Carbon dioxide .	5·0	−0·04	0·12
Methane . . .	10·0	−0·05	0·38
Ethane	9·4	+0·13	0·18
Ethylene . .	10·1	+0·23	0·52
Propylene . .	10·1	−0·12	0·14
n-Butane . . .	15·2	−0·19	0·32
Trans 2-butylene .	10·1	−0·33	0·37
Butadiene . . .	10·1	−0·01	0·31
Average . . .		0·15	0·33

During this 9-months period the mass spectrometer was calibrated only for hydrogen.

British instrument now compares favourably with the American commercial mass spectrometer, the development of which was begun some eight years earlier.

By more frequent calibration of the spectrometer greater accuracy can be obtained, but care should be taken to ensure that the accuracies requested are realistic and significant, and that the plant concerned is willing to pay for the additional effort involved. The ultimate accuracy which entails some ten man hours' work (one hour instrument time, one hour computing, eight hours calibration sample preparation) for the first analysis, and two man hours for each additional analysis, is illustrated in Table IIIB. This analysis[1] was carried out by the Metropolitan-Vickers Electrical Co. on their latest mass spectrometer. Although such high accuracy is rarely needed, it does show that the spectrometer is a flexible instrument and that the normal working accuracy as illustrated in Table IIIA can be increased to meet more stringent demands.

(*e*) *Overall Assessment of the Mass Spectrometer for Refinery Gas Analytical Work*

It must not be supposed from the foregoing that the mass spectrometer is the most suitable instrument for all refinery gas analyses. If a simple Orsat analysis, carried out in the plant control room, will provide sufficient information of adequate accuracy it is obviously quite impractical to carry out these analyses by a spectrometer located in a distant laboratory.

Furthermore, the spectrometer has certain inherent disadvantages which should not be glossed over in a comparison with the alternative methods of analysis. The presence of even small amounts (>2 per cent) of high boiling material ($>C_5$) interferes with the mass spectral computation of the lighter components so that an analysis is impossible without a preliminary distillation to remove the heavy material. The reason for this limitation is apparent when one considers the large number of hexane isomers and their associated varied fragmentation to the lower masses from which the lighter components are mainly computed.

It should also be pointed out that the spectrometer cannot quickly and accurately determine the individual butylene isomers. An infra-red spectrometer is required for such an analysis although a combined M.S.–I.R. method is more satisfactory. Similarly nitrogen and carbon monoxide cannot in general be separately resolved. The total butylene, total pentylene, and nitrogen+carbon monoxide contents can, of course, be accurately estimated by the mass spectrometer.

As against these disadvantages, no single alternative method can analyse for all the components in a mixture of H_2, N_2, C_1–C_3 hydrocarbons as illustrated in Fig 3. In the absence of a mass spectrometer, the analysis would have to be carried out by laborious and less accurate low temperature fractionation combined with combustion-absorption methods.

By and large therefore in the field of refinery gas analysis the mass spectrometer has been found to give more information, more quickly, at a lower cost per analysis, and with a higher accuracy and reliability than alternative methods. Against these advantages must be recorded the necessity for at least one low temperature distillation apparatus to remove the heavy material present in some of the samples and the inability of the mass spectrometer to analyse accurately for the individual butylenes.

It must be pointed out, furthermore, that the mass spectrometer is a very complex instrument and requires greater understanding and more responsible operation at all levels than the traditional refinery laboratory equipment.

As a result new problems in instrument maintenance and recruitment of laboratory staff may be presented.

(*f*) *Maintenance and Trouble Shooting*

The high potential productivity of the instrument compared with alternative methods means that when a mass spectrometer is working to full capacity, it is imperative that major breakdowns must not occur. Apart from an annual shut down coinciding with the major refinery plan, it has been found possible in general to use a mass spectrometer for control work without breaks of longer than 24 hours.

During two years' routine operation of a British mass spectrometer for gas analyses, less than 5 per cent of the actual operating time has been spent on maintenance and trouble shooting. This figure of 5 per cent can be assigned to the specific troubles which might be expected from a complex electronic, high vacuum instrument in the following manner:

(i) Vacuum failure and leak hunting . .	Negligible
(ii) Electronic faults and maintenance . .	<1 per cent
(iii) Mechanical faults and maintenance (motors, relays, and electro-mechanical devices)	<1½ per cent
(iv) Ion source and tungsten filament replacements	1½ per cent
(v) Glassware breakages	<1 per cent

(*g*) *Mass Spectrometry Laboratory Staff*

The spectrometer should be under the direct care of a graduate (or equivalent) who must be responsible for the widest utilization of the instrument for refinery problems,

development, and for specialist maintenance work, particularly on the ion source.

An electronics specialist is not essential and the knowledge of electronics required for routine maintenance and testing can be acquired by staff of a Higher School Certificate or equivalent standard in physics.

The operation of the spectrometer can be very adequately carried out by high quality junior staff of matriculation standard under indirect supervision from a more senior member of Higher National standard. In order to provide wider interest and scope for advancement, these supervisors should be given the opportunity, wherever possible, to work with infra-red, ultra-violet, X-ray, and other specialized methods of analysis.

The computation of the mass spectra can also be carried out by junior staff of matriculation standard, but here qualities of reliability and facility in mental arithmetic are of prime importance. For the more expert in this role, the even more exacting tasks of supervision of computation and interpretation of unusual spectra provide opportunities for advancement.

For an output of 100–120 routine gas samples per week a typical mass spectrometry laboratory staff would consist of: one physicist (or chemist), two instrument operators (who would also assist with computation), and two computers.

Liquid Analyses

The role of the mass spectrometer during the last six years has been considerably extended beyond the C_1–C_5 hydrocarbon range. The conventional gas analysis instrument can now be used without more than minor modification for the analysis or at least the examination of liquid mixtures having vapour pressures of more than 0·05 mm Hg at room temperature. This group includes therefore the hydrocarbon compounds up to C_{11}, and the oxygenated and halogenated compounds which lie within the vapour pressure limitation.

A warning should be given, however, that mass spectral interpretation in this field is in general more difficult than for gas analysis. More development work has to be carried out and with greater precision. Furthermore, difficulty may be experienced in obtaining the pure compounds for the calibration of the individual mass spectrometers. For approximate qualitative work, mass spectra published in America may be transferred to British instruments, but for accurate work the necessity and the consequent difficulty and expense of acquiring pure compounds should be recognized.

A few of the applications of the mass spectral method in control and technological studies of refinery and chemical plant operation are outlined below.

(*a*) *Paraffin-naphthene Isomer and Aromatic Analysis*

Olefin-free hydrocarbon mixtures in the 80–231 F boiling range (*iso*pentane to toluene) can be analysed for the 28 individual paraffin and naphthene isomers, plus benzene and toluene, by a combined M.S.–distillation method[2].

Analyses of this type, *e.g.* for benzene, methyl*cyclo*pentane, and *cyclo*hexane, which cannot be obtained in such detail by any other method, have been widely used in America for platforming catalyst studies.

(*b*) *Aromatics*

Although the spectrometer is not suitable for the separation of the xylene and cumene isomers; benzene, toluene, total xylenes, ethylbenzene, and total C_9 aromatics can be determined rapidly in hydrocarbon mixtures. The resultant benzene and toluene estimations are more accurate than the alternative U.V. method and if the C_9 aromatic and xylene isomer distributions are known, then the accuracy of the whole analysis approaches that of the infra-red method.

(*c*) *Oxygenated and Halogenated Compounds*

The mass spectrometer has been successfully used for the analysis of mixtures of the lower alcohols, ketones, acids, and esters. In the Royal Dutch Shell laboratories, Hageman[3] has estimated the individual components in mixtures of nine fatty acids in the C_1–C_5 range with an accuracy of better than 2 per cent. Mixtures of the lower alcohols and water have been analysed in the same laboratory with a similar accuracy, while in America accurate analyses of C_7 alcohol mixtures have been carried out[4].

Mixtures of halogenated compounds can also be accurately analysed by the mass spectrometer. At Stanlow mixtures of chlorinated and brominated hydrocarbons from chemical plant operations have been successfully analysed.

(*d*) *Type Analysis*

In the preceding work, use has been made of the dissimilarity in mass spectra between different compounds or different isomers. From an examination of the individual mass spectra, however, it has been found that all of the compounds in any one type, *i.e.* paraffins, naphthenes, aromatics, display in their mass spectra quantitative characteristics of fragment distribution and absolute intensity which are common only to that type and therefore distinctively identify that particular type. On this basis it has been found possible in America to determine the paraffin, naphthene, and aromatic contents of depentanized 60–400 F gasolines.

TABLE IIIB

ULTIMATE ACCURACY OF A MASS SPECTROMETER

(*Metropolitan Vickers Double Inlet M.S.2 Mass Spectrometer*[1])

Component	*Synthetic composition mol %*	*Average deviation of 4 M.S. determinations from correct composition mol %*
Hydrogen	5·30	0·11
Methane	10·70	0·10
Ethane	9·85	0·02
Ethylene	4·85	0·12
Propane	9·60	0·05
Propylene	9·95	0·08
n-Butane	10·00	0·03
iso-Butane	9·90	0·04
Total Butenes	16·00	0·10
Butadiene	4·75	0·10
n-Pentane	4·10	0·07
iso-Pentane	4·30	0·05
Total Pentenes	0·68	0·02
Average		0·07

Various extensions to the method permit the determination of the olefins, a group consisting of the *cyclo*-olefins, diolefins, and acetylenes[5]; the condensed ring naphthenes, the *cyclo*pentyl–*cyclo*hexyl ratios[6], and the *n*-paraffin *iso*paraffin ratio[7]. Analyses into similar types can be carried out by the combination of chemical, distillation, and chromatographic techniques, but the dicyclic naphthene content can be estimated only by the mass spectrometer. Comparison of the mass spectral method with the much more laborious chemical techniques shows good agreement for gasolines of wide boiling range. For narrow boiling range fractions, the somewhat larger errors have been assigned to the difficulty of selecting the true average mass spectrum for each individual type.

High Molecular Weight Mass Spectrometry

It has been previously stated that liquids having a vapour pressure greater than 0·05 mm Hg may be examined with a routine mass spectrometer. For less volatile materials the resultant reservoir pressure is too low, preferential adsorption in the inlet system becomes troublesome, and the samples

are very difficult to pump away. These difficulties have been overcome by heating the sample introduction system of the mass spectrometer up to temperatures as high as 400 C. As a result, mixtures containing materials of molecular weight of over 650 have been analysed.

The first work in the high molecular weight field was carried out in the Shell laboratories at Houston[8]. Early successes led to further development and by the end of 1954 the Shell Group had six mass spectrometers engaged in research and investigational work in a molecular weight range which includes gas oils, lubricating oils, waxes, and asphaltenes.

Probably the most important function of a modern refinery is to convert petroleum residues to the much more economically valuable light hydrocarbons. It is thought that it will be possible to carry out this conversion with greater efficiency when more information about the constitution of these residues is available. This is the philosophy behind the current interest in the high molecular weight field.

Group type analysis has been applied with success to lubricating oils and waxes[6]. The saturate portions of these materials have been analysed for normal paraffins, *iso*-paraffins, and condensed and non-condensed naphthenes, and the molecular weight distributions within these groups have been computed.

Chromatographic techniques are used to separate the aromatic fraction into mono- and poly-aromatic portions, each of which may then be analysed by the mass spectrometer into type fractions such as alkyl substituted benzenes and alkyl benzenes with increasing degrees of naphthenic substitution.

The high molecular weight mass spectrometer is also being used in research laboratories to identify lubricating oil and gasoline additives and to investigate the deleterious effects of different types of compounds upon lubricating oil properties. Results of these investigations may well influence the manner of using solvent extraction, and earth and acid treating.

As yet high molecular weight mass spectrometers have not been introduced to the refinery control laboratory. The interpretation of the spectra is usually extremely difficult, in many cases the results are only semi-quantitative, and in general the work in this enormous field is still in a very early stage. Nevertheless the potentialities of the instrument and the method are developing very rapidly and the results will inevitably influence refinery practice.

Continuously Recording Mass Spectrometers

It has been assumed in the previous sections that samples have been brought from the individual plant to the control laboratory. In this way, one mass spectrometer can attend to the analytical requirements of a large integrated refinery. However, due to the raising of product quality specifications, particularly in the petrochemical industry, the continuous analysis of selected plant streams has become an economically sound project, for by this means plants can be operated much closer to the specification limit and thence at a higher throughput. Furthermore, upsets can be detected and rectified at an earlier stage and before large quantities of off-grade material have been produced.

Continuous infra-red gas analysers are in fairly wide use in American chemical plant control[9], and they are playing an increasingly important role in the U.K. In general, however, they can be made to record the concentration of only one component, *e.g.* component A in a mixture of components A, B, and C, and furthermore, although compensation is usually applied, the estimation of A can never be entirely independent of the B–C ratio.

Prototype continuously recording mass spectrometers have been built which record the complete mass spectrum (or selected portions) of the flowing sample in the product lines at frequent intervals. In one application at the Esso refinery at Baton Rouge[10], a C_1 C_2 C_3 stream was sampled every minute and the individual amounts of each of the three components were directly recorded. At regular intervals samples of a synthetic blend of known composition were fed into the spectrometer and the performance of the instrument thereby checked.

In the same refinery a continuously recording mass spectrometer was installed in the panel room of a large pilot plant and a number of lines from the main streams were brought into the inlet system of the spectrometer. Samples from the various lines in turn were introduced to the spectrometer by the automatic programmed operation of magnetic valves, the mass spectra recorded, and the analyses computed electronically.

In this particular application the value of the products, the speed of analysis, the elimination of the cost of transporting samples to a remote laboratory, and the accuracy of the analyses from which extremely satisfactory material balances could be computed, were considered to justify the initial capital cost.

Experience of this type provides practical support for the concept of a mobile mass spectrometer which could be temporarily installed on any plant during start-up periods, test runs, and extensive upsets or at any time when more frequent analyses are required. Pilot plant test runs, upon the results of which the design of future plants is based, appear to present the most attractive pay-back.

The situation can be summarized by saying that prototype continuously-recording mass spectrometers which have been installed in refinery panel rooms have operated successfully over long periods with only routine maintenance. They have been found to be of wider application than continuously recording infra-red gas analysers. The mass spectrometer manufacturers are in the process of developing simple reliable instruments and at a reasonable and competitive price. It is apparent that the high initial cost of the continuously recording mass spectrometer, plus the associated computing equipment if necessary, will have to be very carefully considered in relation to the value of the data obtained and the increased throughput of valuable products which might be expected from the use of such a continuous analyser. For such applications the mass spectrometer will have to be critically compared with other types of continuously recording analysers.

Future Status of Mass Spectrometry

During the last twelve years applied mass spectrometry has expanded enormously. There is no reason to believe that this expansion will cease in the future.

After the initial rapid growth, however, one might expect a process of consolidation to take place during which those functions for which the mass spectrometer is not specifically suited will be handed over to more applicable methods as they are developed or as they become available in the individual laboratories. For example, in the early days of mass spectrometry, considerable effort was expended in attempts to determine individual butylene isomers. The mass spectrometer is certainly not the best instrument for this determination and an infra-red method would now always be chosen for speed and accuracy. As a possible future example, a specific method for the periodic analysis of simple plant streams, capable of being used and interpreted by a plant operator, may, in the form of the vapour phase chromatograph, be in the process of development at the present time.

Each good instrument and method during development is found to have a range of work for which it is specifically suited and by virtue of which it acquires a leading place in the concomitance of analytical methods. From an assessment

of the proven work load capacity, overall accuracy, and versatility of the mass spectrometer (this latter factor being manifested by the fact that one instrument, without modification or varied interpretation, can be used for the gas and liquid range up to C_{12}) it is considered that the mass spectrometer will continue to make an outstanding contribution to refinery analytical work.

Acknowledgment

The author is grateful to "Shell" Refining and Marketing Co. Ltd. for permission to publish this paper.

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Fourth World Petroleum Congress

Further Programme Details

Full details of the organization of the Fourth World Petroleum Congress and of the scientific discussions and debates which are to take place are given in the general programme of the Congress which has recently been sent to intending delegates.

The programme also contains information about the many excursions open to delegates both during and after the period of the Congress and about the industrial plants and factories which it will be possible to visit.

Programme of General Lectures

Details are given in the programme of four lectures of general interest which are to be delivered during the Congress in Rome.

The lectures will be given in the Aula Magna of the Congress Building at Rome's Universal Exhibition Centre and the programme will be as follows:

Wednesday, 8 June. C. A. P. Southwell, managing director of Kuwait Oil Co., London:—"Major Oil Developments".

Friday, 10 June. Prof J. Jungers, of Louvain University:—"The Principles of Fundamental Research in the Design of Petrochemical Equipment".

Monday, 13 June. Prof W. K. Lewis, of the Massachusetts Institute of Technology:—"Energy Resources".

Tuesday, 14 June. Ing. E. Mattei, President of the "Ente Nazionale Idrocarburi", Rome:—"The Development of the Natural Gas Industry in Italy".

Excursion Arrangements

The organizers of the Congress have made comprehensive plans to enable delegates to get to know not only Rome itself but also, by means of specially-mapped tours, something of industrial and artistic Italy as a whole.

Half-day visits to Rome's monuments and museums have been arranged and these will take place every morning and afternoon throughout the Congress period. Special buses will be engaged for this purpose and expert guides will be in attendance. The itineraries will include both the famous monuments of ancient Rome and the main buildings of modern times.

On Saturday evening, 11 June, a sight-seeing tour has been scheduled so that delegates may see the monuments of Rome under floodlights.

In addition, a half-day excursion to Tivoli to visit "Villa d'Este" and "Villa Adriana" will be arranged.

Delegates will be able to select the times which suit them best to make these tours and they will be able to make reservations at the tourist office in the Congress Building.

On free days during the Congress various excursions of one or two days duration are to be organized.

One-day excursions will visit Orvieto, Castelli Romani, Ostia Antica and Lido di Roma, and Cerveteri-Civitavecchia-Tarquinia. A two-day excursion will also be arranged to visit Orvieto-Perugia-Assisi.

In addition to these arrangements two excursions to Naples, of a whole day each, will be arranged so that delegates may visit the International Exhibition of Oil Equipment.

Tourist Excursions Following the Congress

For the days following the Congress, between 16 and 22 June, a series of trips has been arranged, including six itineraries covering the most interesting Italian centres from both the tourist and industrial points of view.

Details of these tours are as follows:

(1) Florence–Milan, with optional two-day visit to the lake district to visit lakes Maggiore, Varese, and Como.

(2) Naples–Taormina–Syracuse–Augusta, or
Naples–Capri–Sorrento–Amalfi.

(3) Le Spezia–Rapallo–Genoa–Turin, with optional two-day extension tour of the Aosta Valley and Mont Blanc.

(4) Florence–Pisa–Leghorn–Larderello, with extension to Venice.

(5) Venice with optional visits to either:
Verona–Lake Garda–Cortina D'Ampezzo (three-day tour), or
Trieste (two-day tour).

(6) Ancona–Rimini–Bologna–Venice, with optional visits to either:
Verona–Lake Garda–Cortina D'Ampezzo, or
Trieste.

Visits to Industrial Plants

During the six excursions listed above visits will be made to a number of industrial plants. Numbers in brackets correspond to the itineraries during which the visits will be arranged.

AGIP refinery at Cortemaggiore (1)
Condor refinery at Rho (1)
Pirelli works at Milan (1)
SARPOM refinery at Trecate (1)
Rasiom refinery at Augusta (2)
Socony–Vacuum Italiana refinery at Naples (2)
INPET refinery at La Spezia (3)
Purfina refinery at Genoa (3)
Fiat factory at Turin (3)
Stanic refinery at Leghorn (4)
Larderello works (4)
IROM refinery at Venice (4 and 5)
Aquila refinery at Trieste (5 and 6)
API refinery at Ancona (6)
Montecantini works at Ferrara (6)

Around the Branches

FAWLEY, LONDON, NORTHERN, PERSIAN GULF, SCOTTISH, SOUTH EASTERN, SOUTH WALES, STANLOW, TRINIDAD

London Branch

On 19 October at Manson House a paper on "Synthetic Rubber in the Commonwealth" was read to the London Branch by J. Walker.

The only synthetic rubber plant in the Commonwealth is that operated by Polymer Corporation Ltd. in Sarnia, Canada, and this is the only completely integrated plant in the world. Here are manufactured rubbers based on butadiene and styrene, commonly referred to as GR-S-types. Also produced are butyl rubbers based on *iso*butylene and *iso*prene. Rubbers which are highly resistant to oil and petrol are made using butadiene–acrylonitrile copolymers, and chlorosulphonated polyethylene and polyesters have been developed and produced on a small scale.

In the manufacture of synthetic rubbers the first operation is to purify and split the gases received from the refinery, which are separated into methane, ethane and ethylene, propane, and butanes. The speaker described how the various types of rubber were developed from these gases. He particularly mentioned a range of oil-resistant rubbers, based on butadiene and acrylonitrile copolymers, which are used as the base material for such products as petrol hose, oil seals, fuel pump parts, etc.

Also mentioned in some detail by the speaker were the oils used to extend rubber. Oil-extended rubber is a recent development, but the increase in the consumption of this type of material shows it to be well-established both for tyres and general purposes. Rubbers containing up to 50 parts of oil have shown excellent results in many applications.

After his talk, Mr Walker answered a great number of questions, the variety of which illustrated the wide interest of the audience. A vote of thanks was proposed by A. W. Deller.

Agricultural Pesticides

A talk on "Agricultural Pesticides" was given on 18 November by J. L. Hunt.

The term "pesticides" covers several groups of agricultural compounds used for protection of farm crops against pests. These include insecticides, miticides, nematocides, fungicides, and herbicides, for the control of insects, mites, eelworms, fungus diseases, and weeds, respectively.

Insecticides can consist of natural and inorganic materials, chlorinated hydrocarbons, organo-phosphorus compounds, or oils. Miticides usually consist of organo-phosphorus materials or benzene sulphonates. The active ingredients of fungicides can consist of copper, sulphur, quinones, or mercury compounds, and herbicides consist of carbamates, substituted ureas, or phenoxy compounds.

Mr Hunt described the wide post-war developments of these materials and dwelt at some length on the mode of action and methods of application of the common pesticides. He described the benefits which accrue from their use and gave the reasons for their increasing application all over the world.

The interest of the audience was reflected in the number and variety of the questions raised at the end of the meeting, which was concluded by a vote of thanks by W. H. Adams.

Persian Gulf Branch

The management of the Qatar Petroleum Company invited the Bahrain Petroleum, Basrah Petroleum, and Kuwait Oil Companies and the Shell Company of Qatar to send representatives to a gathering of the Branch in Qatar from 23 to 25 October last year. The meeting was organized and sponsored by the Qatar Petroleum Company who also provided transport for those attending.

Guests at the annual dinner-dance held by the Northern Branch at the Midland Hotel, Manchester. Left to right; *G. Provest, deputy-chairman of the Branch, Mrs J. C. Wood-Mallock, The Lord Mayor, J. C. Wood-Mallock, Branch chairman, Brig-General Troup-Miller, The Lady Mayoress, Col S. J. M. Auld, Mrs Troup-Miller, E. A. Evans, Mrs E. Haslam, and T. W. Ranson. The Branch was honoured by the presence of The Rt Worshipful the Lord Mayor of Manchester, Alderman R. S. Harper, J.P. and the Lady Mayoress, and the principal guest was Brig.-Genl. Troup-Miller, Officer Commanding the U.S.A.F. base at Burtonwood, Lancs. They were also pleased to have with them the President, Col S. J. M. Auld, and D. A. Hough, the General Secretary.* 106 *members and friends were present, and following the reception by the chairman of the Northern Branch, J. C. Wood-Mallock, the Lord Mayor, and the President, a very enjoyable evening was spent.*

A party of 16 duly converged upon Dukhan, the field's centre, in the afternoon of 23 October from north, east, and west. They were met by a number of the Qatar Petroleum Company's staff, each of whom acted as host to two or three visitors. The accommodation provided was most comfortable and, of course, air conditioned. Once indoors there was no evidence of the barren desert outside, one might equally have been on a visit to somewhere in Britain.

The programme opened at 6.30 p.m. when visitors and hosts assembled in the Qatar Club Lounge for cocktails. G. Heseldin, general manager, then addressed the gathering, the warmth of his welcome and the enthusiasm pervading his brief survey of the Company's operations sounding the keynotes for the whole event.* A. H. R. Grimsey, field manager, introduced the film "Fire at Dukhan" depicting the spectacular and successful fight against the well fire which occurred in 1953. The discussions so initiated continued over an excellent dinner, gastronomically notable for the fresh salmon.

Programme of Lectures and Tours

An early start was made next day at 8.00 a.m. with a series of brief talks on "Drilling in Dukhan" by J. N. Newman (petroleum engineer), "Oil Production from Dukhan" by S. B. Ford (production superintendent) and "Q.P.C. Laboratories" by P. D. Wheatley (petroleum engineer). The party then went on a tour led by Mr Heseldin and visited the laboratories, wells, separators, degassing stations, and pumping stations. A dramatic touch was provided by the DK.35 well where the debris remaining from the fire had been retained *in situ* as a memento to remind all of the courage and ingenuity of the fire fighters, and of the dangers always present in drilling operations.

Lunch was taken in the pleasant staff mess before a further tour taking in the power house, workshops, water distillation units, drilling operations, and the beach club. The party then travelled by car to Umm Said, the shipping terminal, stores, and administrative centre where accommodation was provided in the fine new guest house.

A most enjoyable social evening began with a cocktail party at which the visitors met a number of the Umm Said staff and their ladies. A dinner followed at which Mr Cotter (Bahrain Petroleum), Mr McCall (Kuwait Oil), Mr Teyssot (Basrah Petroleum) and Mr P. de la Calles (Shell) — who also described the drilling platform recently positioned in the Persian Gulf east of Qatar, in turn expressed thanks to the directors of Q.P.C. and to Mr Heseldin and his staff for their magnificent hospitality. Mr Heseldin in reply spoke of the value of such gatherings of Persian Gulf oil men and hoped that the splitting of the Branch into separate units would not preclude the holding of such joint functions. Mr Spence (Hon Sec Persian Gulf Branch) replied that the split was being made purely for administrative convenience and assured the meeting that no isolationism was implied or intended.

The final day began at 8.00 a.m. with talks by P. A. Lilly (terminal superintendent) on "Terminal Operations", by Capt A. D. Piper (acting marine superintendent) on "The Port of Umm Said", and by G. A. F. Grindle (acting chief engineer) on "Engineering Services in Qatar". A tour was then made covering the industrial area, stores, workshops, air conditioning plant, and several new buildings under construction in Umm Said itself, followed by the jetty with its cargo handling facilities and sea water distillation plant, and finally the tank farm and loading terminal, set by the sand dunes.

After lunch the party emplaned at Umm Said, flying over Doha, the capital city of Qatar, the new Shell off-shore drilling rig platform, and the site of Q.P.C. drilling operations in the northern part of the peninsula *en route* to Dukhan whence they dispersed to their separate destinations.

The whole meeting was conducted with the utmost efficiency and warmest hospitality by all the Q.P.C. staff concerned, personally led throughout by Mr Heseldin. All visitors left with a most favourable impression.

*The text of Mr Heseldin's speech is given on page 41 of this issue.

Scottish Branch

A meeting was held in the Grangemouth Petroleum Refinery Recreation Club on 9 December, 1954.

Dr G. H. Smith, M.C., Hon Treasurer of the Branch, presided and introduced the speaker, J. R. Lodwick, B.Sc., A.R.I.C. Dr Smith said that Mr Lodwick was well qualified to speak on his subject—"The Assessment of Quality of Petroleum Products", for since 1947 he had worked in the Products Quality Control Branch of the British Petroleum Research Station at Sunbury-on-Thames. He was previously on the chemical staff of The British Petroleum Co. Ltd., then the Anglo-Iranian Oil Co., at Abadan refinery.

Debris remaining from the fire at well DK.35, retained as a memento by the Qatar Petroleum Company.

The lecture was illustrated by demonstrations and lantern slides. After answering many questions, Mr Lodwick was accorded a very cordial vote of thanks proposed by Dr Smith.

Stanlow Branch

Symposium on Industrial Safety

Forty-three members and visitors were present at a meeting held at the Grosvenor Hotel, Chester, on 17 November last year.

The Chair was taken by A. Cluer and a symposium of three papers on industrial safety was presented. T. K. Urmston spoke first on "The Training and Duties of Fire Auxiliaries", the subject of safety permits was dealt with by E. R. Harding, and H. C. Moore gave a talk on protective clothing.

Discussion was opened by G. W. Power and after the speakers had dealt with a number of interesting questions a vote of thanks was proposed by Mr Cluer both to the lecturers and to Mr Power who had organized the symposium.

Film Show

A meeting held on 28 November took the form of a film show held at the Tatler Theatre, Chester. Six films were shown, some loaned by the Petroleum Films Bureau and some by Shell-Mex and B.P. Ltd.

Personal Notes

H. E. F. Pracy, manager of the Heysham oil refinery since 1948, and a vice-president of the IP, retired on 30 November 1954 after 27 years' service with Shell. Born in 1894, Mr Pracy was educated at Christ's Hospital School and Christ's College, Cambridge, graduating as a B.A. (Honours) in 1915.

Before joining Shell, he served three war years with the Ministry of Munitions and seven years in the chemical industry. During his oil career, he has filled a number of executive positions, first overseas and later at home. After spells of duty in British Borneo and Trinidad he became manager of Shell Haven refinery (1942–44) and general manager of Stanlow refinery (1944–48).

On his retirement, Mr Pracy also relinquishes the appointment of general manager of Trimpell Ltd. The site at Heysham is occupied both by an oil refinery operated by Shell and by a chemical works operated by I.C.I. Trimpell Ltd. is a service company, operated by and on behalf of its two parent companies.

Societies of which Mr Pracy has long been a member are the Institution of Chemical Engineers (of which he is at present Vice-Chairman and Chairman-elect of the North Western Branch), the Industrial Fire Protection Association and The Royal Empire Society.

His successor as manager of Heysham oil refinery is M. Willcocks, formerly assistant manager of Shell Haven refinery, and as general manager, Trimpell Ltd., E. Beesley who comes to Heysham from I.C.I., Billingham Division, Technical Department.

G. E. G. Hope-Johnstone, sales director of the Regent Oil Co. Ltd. has resigned from the Board of Directors to take up the appointment of Vice President of Trinidad Leaseholds (Canada) Ltd. He is expected to leave for Canada early in the New Year.

Mr Hope-Johnstone has held the position of sales director with the Regent Oil Co. Ltd. since January 1951. He has spent some 35 years in the oil industry, including a period in the British West Indies and the Middle East, and for nearly 25 years he has been connected with the marketing of Regent petroleum products.

He will be succeeded as sales director of the Company, and on the Board, by **J. A. J. Nicholas,** at present Regent's general sales manager. Mr Nicholas has been associated with Regent since 1933 when he joined Trinidad Leaseholds Ltd. as a representative. From 1934 until the outbreak of war he was divisional manager, Cardiff. After the war he returned to this position at Cardiff and remained there until 1948. In January 1949 Mr Nicholas was appointed branch manager of the Midland Branch of the Regent Oil Co. He was appointed general sales manager of the Company in January 1951.

B. F. Dodge, Professor and Head of the Department of Chemical Engineering at Yale University, has been elected President of the American Institute of Chemical Engineers.

The 47th Annual Meeting of the Institute was held in New York during December last year and the new President was then installed.

G. Granger Brown, Dean of Engineering, University of Michigan, has been re-elected treasurer. Among the directors elected for a three-year term of office are **D. L. Katz,** Professor of Chemical Engineering and chairman, Department of Chemical and Metallurgical Engineering, University of Michigan, and **W. E. Lobo,** director, Chemical Engineering Division, the M. W. Kellogg Co.

G. H. Freyermuth, who was elected vice-president and a director of Esso Export Corporation from 1 December 1954, joined Jersey Standard in 1928 as a chemical engineer at Baton Rouge refinery. Later he was a research engineer for Standard Oil Development Co., then assistant manager of Sales Engineering for Esso Standard Oil Co., and subsequently manager of the Public Relations Department of Standard Oil Co. (New Jersey),

H. E. Snow, a member of the Consortium delegation which negotiated the oil agreement with Iran, has resigned from the Board of The British Petroleum Co. Ltd. to take up an appointment as general manager of Iranian Oil Participants Ltd.

Mr Snow joined British Petroleum (then the Anglo-Iranian Oil Co. Ltd.) in 1921 and became a managing director in 1952. He served as secretary of the Petroleum Board during the war and was awarded the O.B.E. in 1946 and the C.B.E. in 1952.

P. C. Miller has been elected a vice-president of Esso Export Corporation, the international sales affiliate of the Standard Oil Company (New Jersey).

Mr Miller first joined the Standard Oil Company as an office boy and later entered the export field. With the establishment of Esso Export in 1944, Mr Miller became a director and supervisor of foreign traffic. In 1948 he became assistant manager, and in 1953 acting manager, of the sales and traffic department.

In 1941 Mr Miller was loaned to the British Government to organize the office of the Petroleum Board in New York which helped to maintain the flow of petroleum products to Britain during the war.

Dr W. D. Scott, who recently relinquished his appointment with Monsanto Chemicals Ltd., has joined British Tyre and Rubber Co. Ltd. as personal assistant to the managing director P. W. Howard.

V. Butler, C.M.G., who became a civil servant during the war and for the last eight years has been an Under-Secretary in the Ministry of Fuel and Power, resigned from this position and joined the Shell Petroleum Co. Ltd. on 1 January 1955.

Bertram Baden, M.C., chairman of the Matthew Hall Group of Companies was, with his fellow directors, host at the Company's annual cocktail party at the Dorchester Hotel on 7 December. An exhibition of models and photographs illustrated the activities of the Company in various parts of the world.

British Tar Confederation

Major A. J. Saunders has been elected president of the British Tar Confederation for the year 1954-5. Chairman of the Executive Board is S. Robinson and there are two vice-chairmen, R. H. E. Thomas, O.B.E. and H. F. H. Jones, M.B.E.

Her Majesty's New Year Honours

Barony

Sir William Fraser, C.B.E., LL.D., chairman, The British Petroleum Co. Ltd. Sir William first became a director of The British Petroleum Company in 1923 when it was known as The Anglo-Persian Oil Company. He became deputy chairman in 1928 and succeeded the late Lord Cadman as chairman in 1941.

Knighthood

Ivor Richard Cox, D.S.O., for services as managing director, Metropolitan-Vickers Electrical Co. Ltd.

Leonard Sinclair, chairman and managing director, Esso Petroleum Co. Ltd. Mr Sinclair was elected to the Board of Directors of the Anglo-American Oil Company in 1943 and was appointed managing director in 1949. In 1951 he became chairman and managing director of Esso Petroleum Company.

Sir William Fraser (left) and Mr Leonard Sinclair.

G.C.B.

Sir John Primatt Redcliffe Maud, K.C.B., C.B.E., Permanent Secretary, Ministry of Fuel and Power.

C.B.E.

Robert Crichton, for political and public services in Scotland. Mr Crichton was managing director of Scottish Oils Ltd. until his retirement in March 1954.

M.B.E.

Haydn Iestyn Evans, administrative assistant, Shell-Mex and B.P. Ltd.

Major H. G. McGrath, catering manager at the Kent oil refinery of British Petroleum Co. Ltd.

Charles Bruce Pitblado Morton, D.S.O., D.F.C., assistant to the chairman, Matthew Hall & Co. Ltd.

B.E.M.

Edwin James Hadlow, pumpman, tanker *Latirus*, Shell Tankers Ltd.

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Coal and Black Oils

Their Relationship in the Western European Fuel Market

Co-ordinated fuel policies favouring the use of the best and most rational types of energy for any given purpose, and safeguarding the general long term interests of both the coal and oil industries, are advocated by the United Nations Economic Commission for Europe (ECE) in a report published recently.*

Post-war difficulties in selling coal in continental western Europe led the Secretariat of ECE to make a special study of the relationship between coal and petroleum products which might compete with it in the west European fuel markets, and the results of this study have now been made public.

Fear that the situation would gradually worsen was intensified by the general trend in the U.S.A. where the market for coal has been sharply limited by the competition of oil. The Secretariat has, however, concluded from its studies that energy requirements in Europe will steadily increase during the next ten years. Assumptions, based on varying rates of increases in gross national production and increases in efficiency in energy, show that the demand for energy will at least remain stationary, while at most, there may be a very large increase in requirements.

Past Trends

The Report begins with an examination of past trends in the consumption of solid fuels and black oils from the point of view of their contribution to western Europe's energy supplies. The part played by black oils in these supplies has been found to be modest—their share in the total energy consumption of western European countries having increased from two to eight per cent between 1937 and 1953.

Coal-importing countries have turned increasingly to fuel oil (principally owing to cheaper transportation and greater certainty of supplies), but coal-producing countries have continued to rely on coal. A study has been made of the use of oil by shipping, the railways, the iron and steel industry, the electric power industry, the gas industry, and by household consumers. Of these, shipping alone has shown a marked preference for oil and it is thought that the change to oil in the world merchant fleet may be virtually complete in another ten years if the trend of the last thirty years continues.

*"Relationship Between Coal and Black Oils in the Western European Fuel Market". Prepared by the Industry Division, Economic Commission for Europe. Available from all sales agents for United Nations publications, including H.M. Stationery Office, P.O. Box 569, London, S.E.1. Price 3*s.* 9*d.*

Supply and Demand in 1963

The Report deals next with the prospective demand for energy in 1963 and the implications of a number of assumptions are worked out.

In 1953 apparent consumption in the general energy market in western Europe amounted to some 660 million tons in coal equivalent. Assuming a 2.5 per cent average annual increase in gross national production and a gradual reduction in the energy consumed per unit of national output of 1.25 per cent per year, the apparent consumption in the general western European energy market could be expected to reach 750 million tons by 1963, an increase of 13.5 per cent over the 1953 figure.

The Secretariat has assumed that the proportion of black oils produced will not be higher than in 1952 and probably no higher than that planned for 1954. It may, indeed, be lower. On the most favourable assumptions, the quantity of black oil available on the general energy market will not, it is thought, amount to more than 55 million tons or 82.5 million coal tons equivalent in 1963, and might, under certain circumstances, be no more than 45 million coal tons equivalent.

Conclusions

Taking into account the assumed net effect of external trade in white and black oils in 1963, and the expected position with regard to brown coal, hydro-electricity, and natural gas, the ECE Secretariat considers it reasonable to assume that over the next ten years the position in the general energy market would possibly be balanced and at times might be one of shortage. In any event, it would appear that a radical contraction of the market for hard coal is improbable.

Temporary gluts of energy supplies, are however, likely to occur and, for various reasons given in the Report, the burden of making adjustments under these circumstances will fall mainly on coal. This, it is contended, might be detrimental to the best long-term interests of the economics of western Europe. The oil industry, with its ability to vary the proportions of white and black oil output, is, in the opinion of the Secretariat, better able to make adjustments in times of temporary oversupply.

It is these considerations which have led the Secretariat of ECE to advocate some co-ordination of fuel policy so that the superior flexibility of black oil production can be a stabilizing factor in the general energy market. Given such co-ordination, the further growth of dual-firing could be regarded, states the Report, as an unmixed blessing which it might well be found desirable to stimulate positively.

Co-ordination would involve at least temporary burdens to be borne by both the coal and oil industries, and the adaptation of rational marketing policies, particularly in times of surplus. It would be unrealistic, it is stated, to envisage that all the necessary contraction in output would be borne by black oils. The coal industry would have to increase its own flexibility by various means such as the provision of increased stocking facilities.

In addition to this economic discussion of the relationship between coal and black oils, the Report contains a chapter dealing with the comparative technical characteristics of coal and oil as heat-producing agents which includes a survey of the present extent and possible future growth of installations permitting rapid switches from coal to fuel oil.

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Trade Literature, etc.

Low Frequency Transformers

A range of hermetically sealed very low frequency transformers suitable for geophysical and similar applications is now being produced by Avis and Baggs Ltd., 11–13 Gosbrook Road, Caversham, Reading, Berks.

Treatment of Drilling Muds

Two new colloidal materials for the treatment of drilling muds are being produced by R. Escourrou, 29 allées François-Verdier, Toulouse.

Free Pistons

A booklet illustrating a range of automatic free pistons for gas lift and flowing wells is available from Garrett Oil Tools Inc., P.O. Box 2427, Longview, Texas.

The Serck Organization

An illustrated brochure published by the Serck organization describes the work of the Company's many divisions and research laboratories. Of particular interest to the petroleum industry are the Company's engineering and tube milling activities.

P.V.C. Protective Aprons

A range of protective aprons is manufactured by James North and Sons Ltd. which are said to offer especially high resistance to abrasion, chemicals, and water. The aprons are suitable for workers handling petroleum products and for laboratory workers generally.

Baird and Tatlock Ltd.

New offices and showrooms have recently been opened in Manchester by Baird and Tatlock (London) Ltd., makers of scientific instruments and laboratory equipment. The address of these new premises is 58 Lever Street, Manchester.

The new northern manager of the B.T.L. organization is A. E. Hobson who previously held the position of assistant home sales manager of Baird and Tatlock (London) Ltd.

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CRUDE OIL PRODUCTION

	1954	
	November	*Jan.* to *Nov.*
	Tons	
Iraq Petroleum Co. Ltd.	1,925,631	21,673,433
Basrah Petroleum Co. Ltd.	352,147	4,148,743
Mosul Petroleum Co. Ltd.	104,933	1,175,842
Qatar Petroleum Co. Ltd.	424,219	4,274,882
	Brl	
Kern Oil Co. Ltd.:		
California	99,695	
Trinidad	79,920	

Oil Production in Qatar

IP Persian Gulf Branch Meeting

At a meeting of the IP Persian Gulf Branch held in Qatar from 23 to 25 October last year, representatives were present from the Bahrain Petroleum, Basrah Petroleum, and Kuwait Oil Companies, and from the Shell Company of Qatar. The visitors were greeted by G. Heseldin, general manager of the Qatar Petroleum Company which had organized and sponsored the meeting.

After welcoming the visitors to Dukhan, Mr Heseldin gave a brief history and description of the work of the Qatar Petroleum Company and said:

The Company holds a concession for the production of oil in the sheikdom of Qatar and its territorial waters. The Qatar

Photos by courtesy of Iraq Petroleum Co. Ltd.

The stores area, Fahahil.

Peninsula is approximately 100 miles from north to south and 50 miles from east to west. Harbours, suitable for the use of small craft, are found on both sides of the Peninsula but it took considerable survey work to find a suitable deep water port. With the help of the Admiralty, however, we located and charted a deep water channel leading to Umm Said on the east coast, where our terminal is situated. On the seaward side Umm Said is very good; the world's largest tankers can be accommodated quite close inshore, but we are not too well favoured as far as the land side is concerned and have to put up with a strip of foreshore subject to flooding at very high tides.

I will confine my remarks to post-war development and merely say that before the war the Peninsula was surveyed and the Dukhan anticline located by geological mapping, and three wells were drilled—the discovery well being in the camp here at Dukhan. DK. No. 2 was drilled some 9 miles south of DK. No. 1 and DK. No. 3 was drilled well down the east flank, roughly as a cross-section well to DK. No. 1.

The first well found oil in the No. 3 limestone; the second well found oil in No. 3 limestone and gas in the No. 4; well No. 3 found water in both the No. 3 and No. 4. All three wells were irretrievably plugged in 1942.

Subsequent drilling has shown the Dukhan structure to be 20 miles in length—4 miles across the axis in the north and some 2 miles in the south. On starting up operations after the war, a seismic survey was carried out with the idea of helping to determine the shape of the structure.

During and after the war plans for putting Qatar on to production were prepared. On starting up operations after the war further wells were drilled to prove the structure, and it was subsequently decided to go ahead with a production scheme based on an output of one million tons per annum from the No. 3 limestone. While this scheme was under way it was decided to raise the output to two million tons per annum.

About this time it was found by drilling that there was oil in the No. 4 limestone; although the No. 4 has a large gas cap there is a ring of oil around the structure. Additional production wells were drilled and a degassing and pumping station was built at Khatiyah in the northern part of the anticline.

A pipeline was constructed across the Peninsula starting from Umm Bab, and a terminal was built at Umm Said with two sea-loading berths. Owing to supply difficulties, the pipe across the Peninsula was a continental size, 14½ inches o.d., which gave a pipeline capacity of 4·6 million tons per annum. This was taken advantage of when the production target was later raised to 4½ m.t a. (100,000 b.d.). A second degassing station was then built at Fahahil, some 11 miles south of Khatiyah, and connected to the pipeline at Umm Bab.

Recently it has been decided to increase production still further and we are now in the process of drilling the wells, putting in a third degassing station, at a place called Jaleha, some 10 miles further south of Fahahil, and increasing our pipeline and storage facilities. 32 miles of 2-inch pipeline and the storage tanks at the terminal have already been completed and it is intended to put in a third sea-berth at the terminal.

The crude from the No. 3 limestone has a specific gravity of 38° A.P.I., and that from the No. 4 limestone 42° A.P.I. After finding the oil in No. 4 limestone all our production wells have been confined to this horizon, where the greater reserves lie.

Off-loading petrol from M.C. Afri at Umm Said.

The major problem facing the Company was, of course, that of supply and support. The western side of Qatar was uninhabited, waterless, and practically devoid of animal and vegetable life. The Umm Said area was in the same category. The original supplies were transhipped at Bahrain from ocean steamers and brought by barges and launches to Zekrit, on the north of the Dukhan anticline. Water was at first brought from Bombay and Bahrain.

The first cargoes brought in to Umm Said were by special arrangement with the shipping companies and consisted of the terminal tankage. Now that the channel has been buoyed and lighted and is used by tankers, we have persuaded the shipping companies to make Umm Said a port of call and we have succeeded to such an extent that the British India Company have recently added Umm Said as one of their regular calls in the Persian Gulf.

The original drilling camp was at Dukhan, in close proximity to the No. 1 well and, as we expanded, facilities were

Exchange manifold at the degassing station, Qatar.

built up round this existing camp. It became obvious that facilities at Dukhan were too small—the site was congested—and to extend the industrial area we should have to abandon the original sites and start afresh with a new layout.

Considerable thought was given to the location of a permanent camp site and it was finally agreed to develop Umm Said as the principal service and administrative headquarters. This development is now taking place. Umm Said has the added advantage that, in addition to being the terminal, it is the port of call for steamers.

In planning the site of the Umm Said industrial and residential area it was decided to make the stores area a focal point, with the mechanical workshops, transport, and commissariat buildings surrounding this central area. Each facility, however, can expand in at least one direction; thus the initial layout is not too large and does not cause unnecessarily long travel distances between various points. Quarters for both monthly-paid and daily-paid employees are within easy reach of the industrial area without being too congested or too scattered, and at the same time maintaining their different amenities.

With the commissariat facilities, which include the laundry, shop, food stores, and so forth, we have included the central air-conditioning plant, as refrigeration and air-conditioning services go together and naturally the commissariat area requires quite a large amount of refrigeration.

A jetty was originally built for the mooring launches but when Umm Said became the port, it was necessary to use this jetty for off-loading cargoes. It says something for the way in which we were able to handle the cargoes from this small jetty that we have frequently received well over 10,000 tons a month of incoming cargoes. All cargoes for Qatar, those for the Government, and the Shell Company, are handled by our facilities at Umm Said.

There is a small floating jetty at the signal station which the mooring launches can use in reasonable weather and this saves considerable time taking documents to and from the tankers, rather than having to use the main jetty.

There is under construction at Umm Said a big extension to the power house and the connecting-up of the lines from the newly constructed tanks, including a new foreshore line. A small topping plant, an additional water distillation plant of increased capacity, a staff swimming pool, additions to the various types of accommodation, including a club for monthly-paid employees, are being built, as are also the new commissariat premises, including a shop and offices.

We propose to build a large extension to our hospital next year and also to construct the permanent transport workshops, stores, and facilities, and commence construction of the main administrative offices.

Potable water has been difficult to find and both at Umm Said and Dukhan a mixture of distilled sea water and well water is used.

Development has taken place during a period of intense scarcity of materials. We have had to substitute equipment for that which would have been our choice in more normal times. We have great difficulty in obtaining materials and equipment from the dollar areas and a great deal of substitution of sterling for dollar material has occurred. All our transport is bought in the U.K. and a very large part of our production and drilling supplies, which before the war came from the U.S.A., are now obtained from Britain.

An endeavour is being made to reduce man-hours on the job by choosing prefabricated buildings and we feel that we have made a success of the prefabricated staff houses and small offices.

Schemes have been introduced for training the local Qatari and, owing to the diligence and understanding of our foreign staff, the former pearl-diver and Arab bedouin have been trained to undertake quite responsible tasks. As an example of what has been achieved in this respect we employ 8 Qataris for every one British or American member of the staff.

We are fortunate that the Ruler of Qatar, His Highness Shaikh Ali bin Abdullah al Thani, is most sympathetic and helpful towards our problems and that in the Ruler's Representative, Abdullah Darwish, we have a man of outstanding ability with whom to deal.

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THE VOICE OF THE PAST

The Clouded Crystal Ball

We are standing on much firmer ground, however, when we look at the subject from the point of view of available resources. It was this, and this alone, that enabled the United States to outstrip Great Britain, and it will be this factor that will place Russia far above any other petroleum producing country in the world. Thus, from a very general view of the conditions and possibilities of the two industries, there is every prospect that the centre of gravity of the petroleum industry in all its departments will be shifted within a few years entirely to the East.—Editorial in the *Petroleum Review*, 1900.

Fascinating Uses for Petroleum

I may tell you that two litres of petroleum spirit contain sufficient energy to lift the Eiffel Tower a distance of two metres from the ground.—From a paper presented at the 1st International Petroleum Congress, 1900.

Recent Trends in Handling Oil Products in the U.K.

At a meeting of the Economics and Operations Group of the Institute held on 14 October, S. D. Colwell gave a talk on "Recent Trends in Handling Oil Products in the U.K."

Mr Colwell opened by stating the terms of reference within which his talk would be given, indicating that he would not deal with refineries or refining except where they were part of the distribution machinery. It would be assumed that the crude had already been landed and refined and that the finished products were located at the refineries or main terminals ready for the marketing side to take over and distribute to the user.

Mr Colwell explained that the subject would be dealt with under three main headings: storage, issues, and distribution and marketing, and also said that he had brought along a panel of three colleagues (Messrs C. H. Selley, A. H. Stephenson, and S. J. Treen) whose help he would enlist in the discussion following the talk.

Storage

On the distribution side of the industry in the U.K., said Mr Colwell, there had not been much development of new techniques in actual main storage. The industry was, however, undoubtedly more conscious of desirable good practices in bunding than at any other time and the speaker suggested that many of his listeners would know of installations where, if they were rebuilding, they would hesitate to reproduce the concentration and spacing once thought to be suitable when conservation of land occupation was regarded as all-important. That was not to say, however, that some of the extravagant demands made by some local authorities—especially since the Avonmouth fire—were necessary or acceptable. Undoubtedly the special measures resorted to during the war, *e.g.* additional bunds, bricking, etc., had made everybody more conscious of techniques for preventing out-flow and it was to be hoped that the "Marketing Safety Code", Part II of the "Model Code of Safe Practice in the Petroleum Industry" would clarify the position generally.

Referring to fire prevention and protection, Mr Colwell again mentioned the war as responsible for a very marked improvement in the standard of fire-fighting equipment. Since the war research had been conducted into the respective merits of top and bottom foam injection but definite conclusions had not yet been reached. A study had been made of compressed air methods of fire-fighting with heavy oils (a method suggested in the U.K. more than 30 years ago but so far developed only in the Western Hemisphere) but no practical application had yet been made in the U.K.

Co-operation with local fire brigades had made very marked progress in recent years. This had enabled the industry to explain its special problems and assist in developing techniques for dealing with emergencies. In many cases regular joint exercises were undertaken.

Issues

This topic formed the bulk of Mr Colwell's talk. More and more attention was being devoted, he said, to methods of restricting and preventing vapour losses. As examples the speaker mentioned the tendency to instal automatic measuring devices on storage tanks to enable the contents to be determined without opening dip pipes, the elimination of free venting of storage tanks, and perhaps most important, the reduction of double handling by eliminating the use of overhead service tanks for loading cargoes or road and rail vehicles in favour of direct transfer by pump to such vehicles from main storage. It had also been found that this practice had other advantages for it eliminated the cost of erecting expensive structures for the support of service tanks and the increasing cost of preventive maintenance of such equipment. There were, of course, operational and store-keeping objections to withdrawing from main storage at the same time as it was being replenished, but where only one main storage tank was available this difficulty could be overcome by providing ground-level service storage—*e.g.* a 30 ft × 9 ft tank sufficient to cope with a few hours' issues which could be brought into operation when the two transactions were likely to coincide.

The Road Wagon Filling Gantry

Considerable developments had occurred in this field in recent years. The practice of the industry in the past had been to load road tank wagons through flexible hoses from depot gantries by means of a screwed gas-type connexion. Naturally, in such circumstances, unless hoses were to become cumbersome to handle, the diameter size would be comparatively small and very speedy loading rates would not therefore be obtainable.

At present the trend in the U.K. was for the industry to adopt open manhole loading which had been so successfully employed for many years in the U.S. The most usual type of open lid, used in conjunction with suitable loading arms, facilitated the loading of spirit vehicles at rates of approximately 300 g.p.m. The open manhole had the advantage that there was no back pressure to contend with and the tank could usually be inspected to ensure that the previous load had been completely discharged. Open manhole loading was usually associated with a special loading arm on the gantry—a device by which the arm (which was of appropriate size for the loading rates desired) could be readily adjusted and moved to enter the open manholes of the vehicle. The demands on manpower at the gantry for loading control could be substantially reduced by these and other devices.

Vehicles

The speaker suggested that the use and construction of road motor vehicles was largely governed by:

(*a*) The Ministry of Transport Use and Construction Orders.

(*b*) The Home Office Conveyance Regulations.

(*c*) The Factories Act, which controlled manhole sizes for tanks.

(*d*) Taxation of the vehicle and its fuel.

The changes in (*b*) campaigned for by the industry had resulted in an increase in the permissible quantity of motor spirit for conveyance by road from 2500 gallons in 1939 to 4000 gallons at present.

With regard to (*a*) the trend of future legislation was interesting. The Government had already indicated that existing legislation would shortly be amended and the broad effect of this would be:

(*i*) to permit an increase in width in certain circumstances, and

(*ii*) to permit an increase in laden axle weights.

These changes opened up possibilities of reducing operating costs, of which perhaps the most significant was the extension of the maximum of 4000 gallons, hitherto restricted to spirit or gas oil–derv ranges, which was afforded by the increase in the gross vehicle laden weight limit from 22 to 24 tons.

With regard to taxation, both of the vehicle and its fuel, Mr Colwell observed that this had had its effect on the development of road vehicles in the petroleum industry. Manufacturers had sought to lighten the weight of the chassis and the superstructure, including the tanks, pipelines, etc., so that a higher payload could be carried for the same tare weight, and considerable progress had been made in this direction. Moreover, most of the larger vehicles in the petroleum industry were now being driven by diesel engines, with their improved specific fuel consumption, rather than by the gasoline engines which were universal only a decade ago.

Turning to the mechanical aids available to the driver of the vehicle in his task, the speaker said that it was customary originally for some products to be pumped off by a manually operated semi-rotary pump, but this type of equipment was now obsolete and where products had to be pumped off the vehicle a mechanically driven pump was provided.

Another trend was towards the fitment of mechanical tailgate hoists to open vehicles. These were operated from the engine of the vehicle and served to increase the utilization factor of the vehicle and reduce the manpower requirement. Other mechanical aids which were being increasingly adopted on petroleum distributing vehicles of all kinds with the same objective were direction indicators, windscreen wipers, better lighting for forward and reverse driving, and power assisted brakes. Many new ideas were still under discussion or trial: light-weight hoses, quick couplings for hoses, flowmeters for loading and discharge, bottom loading of wagons, the elimination of some items which require maintenance, and the adoption of items which would spread the mileage without maintenance; but we should secure the greatest increase in productivity by an increase in the legal speed of vehicles.

Mr Colwell went on to compare the relative merits of articulated and rigid vehicles. The petroleum industry was adopting more and more articulated vehicles for the following reasons:

(*a*) The interchangeability of semi-trailers facilitated tanks being kept for a particular product, providing the design of the turntable was kept standard throughout the fleet. It was a distinct operational advantage and made for safety if tanks which were used for spirit could be kept for that product, and, more particularly, if tanks which were employed in the burning oil trade could be definitely excluded from carrying low flash point products.

(*b*) The smaller turning circle of the articulated vehicle, as compared with the rigid vehicle, facilitated manœuvring in confined spaces and on the forecourts of retail filling stations.

(*c*) The semi-trailer had proved capable of very long life and this reduced the depreciation. Semi-trailers frequently lasted twice as long as tractor units.

(*d*) There was an economy of workshop space when an articulated vehicle had to be taken in for overhaul, since half of the vehicle could be left outside the shop when only the other half required repairs.

Against these advantages, however, the articulated vehicle had some disadvantages which the speaker summarized as follows:

(*a*) The initial cost of an articulated vehicle was higher than the initial cost of a comparable rigid vehicle, and this difference was accentuated if several semi-trailers were purchased against each motive unit.

(*b*) The articulated vehicle had in the past been subject to what was known as jack-knifing, and this could be disconcerting for the driver and sometimes led to the need for costly repairs.

(*c*) The articulated vehicle had not proved itself to be as road-worthy in adverse weather conditions, particularly when traversing snow or ice.

(*d*) In general, the articulated vehicle had tended to be heavier than the rigid vehicle.

(*e*) The articulated vehicle was somewhat less comfortable when being driven empty owing to the shorter wheel-base of the tractor unit, and since petroleum-carrying vehicles usually covered 50 per cent of their mileage in empty condition this was of considerable importance.

Rail Cars

The use of rail cars for moving petroleum products to depots or direct to customers was tending to decline, although substantial quantities were still carried by this means. There had, perhaps, been less development in this direction than elsewhere. Our rail cars were still mainly of the 14-ton category, though some, particularly fuel oil cars, were of a nominal 20-ton capacity. The tendency to move in trainloads as distinct from the despatch of individual cars to individual depots, which had been developed during the war, had been continued. This was largely because of the better utilization that could thereby be achieved in turn-round rather than from any direct economic advantage, since, as far as the speaker was aware, the railway autnorities had not offered rate inducements for train movement as such.

An interesting development in the U.K. within the last few years was the bitumen oil-fired car. The system employed consisted essentially of heating up the bitumen not by steam, which was the normal practice, but by the application of direct heat. Two 8-inch steel tubes were introduced into the barrel of the rail car, to which were attached what were in reality flame throwers or burners. The flame extended into these tubes some 4 ft. The tubes were carried almost the entire length of the car and were brought back for exhaust gases to escape at the top of the tank. Tests with these cars had shown that temperatures could be more speedily raised than with steam.

Ships

The impact of home refining on the U.K. had been responsible, amongst other things, for the growing tendency to use ocean-going tankers on U.K. coastal movements. The fact that so large a proportion of the operating time of these vessels was spent on loading and discharging made them less attractive, from the point of view of operating costs, on the short distance coastal voyages than on the long distance ocean-going voyages. In order to improve their competitive position with other means of transport in the U.K. the loading and discharging times would have to be cut down. Mr Colwell thought that this might well point the way to a programme of increased storage at installations (to ensure one port of discharge) and to an increase in the size of pipelines to enable full use to be made of the ship's pumping capacity in discharging the cargoes.

A fillip had also been given to coastal shipping by the home refinery programme insofar as it had involved a reassessment of the basic pattern of distribution and in doing so had encouraged distributors to look for economies in laying down costs by water transportation. With more and more of the issues from refineries and installations being effected by water, the number of coastal tankers was increasing. Those employed today ranged in carrying capacity from 200 to 3000

tons, the 750–850-ton vessel being the one in most general use.

Estuary craft were increasingly being designed so that they could carry the maximum cargoes on difficult waterways, *e.g.* river courses of comparatively shallow depth, strong tides, and acute bends.

Typical of those now under construction were the vessels with a length of 145 ft, beam of 27 ft, loaded drafts ranging from 5 ft 6 inches to 10 ft 6 inches, a cargo capacity of approximately 500 tons, and a speed of 8 knots.

Aviation Spirit

The rapid development in the efficiency of aircraft engines over the past few years had increased the necessity for ensuring that aviation gasolines and turbine fuels were delivered to aircraft as clean and as moisture-free as practicable. Throughout the whole flow line from the installation to the airfield depot or R.A.F. station, a general tightening up of control had occurred during the last few years. So far as aviation turbine fuel was concerned, the fuel was allowed to settle in storage for specific periods before being drawn upon for loading road wagons, etc., and withdrawal from these tanks was from the surface of the liquid by means of swing pipes or floating hoses. These precautions were adopted to allow sediment to fall to the bottom of the fuel and not be withdrawn from the tank in the process of loading vehicles. Fuels were carefully filtered at each step of their movement from storage to aircraft.

Mr Colwell thought the development of the aircraft fueller was of special interest. The first vehicle which had been manufactured specifically for the fuelling of aircraft at aerodromes in the U.K. was produced in 1934 and was of 700 gallons capacity. Today there were many vehicles employed in this specialized business with capacities of 4000 gallons. The rate of delivery had increased from 25 to 400 g.p.m., this being a direct result of the increase in the size of aircraft and their fuel requirements. The discharge of fuel into the aircraft was measured by a flowmeter, frequently fitted with a pre-set device. The fuel was invariably delivered through a wet hose, sometimes terminating in a hand-operated nozzle, or, alternatively, with a wet hose coupling. After mentioning the possibilities of the substitution of hydrant fuelling systems for the mobile refueller method, the speaker passed on to his next topic.

Mechanical Handling Devices

During the past few years labour had been in short supply and had become increasingly expensive. Industry generally, therefore, had devoted a good deal of time and research to finding ways and means of reducing the labour required to handle its products. In the oil industry a large field existed in this respect where package filling and handling were concerned, and in consequence mechanical aids had been introduced into the oil industry in increasing numbers and types.

All types of packages were now being stored and conveyed on pallets, not only inside the installations where these packages were filled, but also for supplies travelling from such installations to receiving depots. Fork trucks were being widely used for lifting and conveying pallet loads and packages, and many other forms of mechanical aid, such as conveyors and hoists, had been developed and introduced into the oil industry during the last few years. These devices showed a very large pay-off in labour saving, prevention of accidents, economical use of floor space in buildings, preservation of packing appearance, and lorry loading and discharging time.

Methods of decorating packages at filling installations had also improved during the last few years. Machines were now extensively employed for mechanical silk-screen stencilling of drums which not only gave a vastly improved decoration but also did the work far quicker than was possible by the old methods of brush stencilling.

Marketing and Distribution

Mr Colwell passed on to his third main topic by making the point that the object of all the developments which he had been describing was to serve the primary purpose of marketing products efficiently and profitably.

With that aim in view, the first necessity was to increase the size of the load in the last stages of distribution. Solid progress had been made in this direction. Every encouragement had been given by the larger companies to consumers to increase the size of storage. Considerable progress had been made in this direction as a result of the strike of tanker drivers which had taken place about a year ago.

The fuel oil trade had presented fewer problems in this connexion. Customers were themselves the users (generally solidly established business concerns) who accepted as axiomatic the need for a sound storage reserve. Secondly, the size of drop had grown with the size of the delivery potential—road vehicle, train, barge, or coaster.

In the case of kerosine, some wholesale distributors had "hived off" their small business to agents who had taken over the "retail" function which had so long hampered the identification of this product with the techniques applicable to most of the other products in the petroleum range.

Streamlining the Distribution System

To match these developments, the larger distributing companies had been giving thought to the untidy pattern of depots they had built up over the years. Many still had facilities that had been determined by the capabilities of the horse-wagon and the modest consumption of petroleum products in our fathers' childhood. These were fast disappearing and the older companies were adopting the pattern that the newer arrivals had been able to start with—larger, well-planned storage centres capable of speedy loading and handling processes, and operating over distances of 50–60 miles. In this, the coastline and inland waterways had invited the planner, where substantial business made it attractive, to seek the lowest "laying down" costs by coastal and barge transfer from refineries and main terminals; if no other encouragement had been there to inspire it, the need to rethink all of the economics of distribution as a result of the impact of home refining had ensured that this necessary surgical operation should be performed.

Discussion

R. F. Leach opened the discussion and asked for the speaker's views on the course of future competition between flowmeters and dipsticks. He wondered why the dipstick had survived so long. Mr Colwell, in reply, said that he thought there had been a certain amount of resistance to the use of flowmeters. Apparently it had been felt that the flowmeter did not measure so accurately as the dipstick (when used by an experienced operator). Furthermore, the flowmeter was quite an expensive item to instal.

Further questions from Mr Leach were answered by Messrs Colwell and Selley. On the question of the use of pipelines in the U.K., Mr Colwell felt that the existing pipelines system built during the war was not used because it would provide only an insecure distribution system—it might be requisitioned at any time. As regards building new pipelines, Mr Colwell suggested that the initial cost was one of the main deterrents.

Asked why the industry did not make more use of trailers, Mr Selley suggested the reasons were:

(*a*) In the case of motor spirit and products with a low flash point there was a very severe restriction in the Conveyance Regulations.

(*b*) In most cases, the addition of a trailer to a wagon made the two together rather a cumbersome vehicle.

(*c*) Any vehicle operated with a trailer had to carry a driver's mate.

J. H. M. Clark brought the discussion back to the question of pipelines by mentioning the Le Havre–Paris pipeline. Surely, he thought, similar pipelines could be built in the U.K. to run over the limited distances between the supply points and the big consuming centres. Mr Colwell stood by his original statement. His Company, he said, had made a broad study of this question but had found that it might take 25–30 years before a pipeline began to pay.

Next, Mr Selley confirmed a suggestion by S. Shragah that corrosion was indeed a problem—not only in vehicle tanks, but in many other ways as well. The oil industry was experimenting with many different types of coatings and linings for tanks, some of which, in Mr Selley's opinion, showed great promise although none of them had yet entirely proved themselves. Stainless steel tanks were a good solution from the engineer's point of view but they were very expensive.

In answer to a question from E. A. Reynolds, Mr Treen mentioned that mechanical handling had cut the loss due to accidents in one particular plant from a rate of about £950 per annum to a rate of some £60 to £70 per annum. Moreover, vehicles were being loaded today in 20 minutes which before the introduction of mechanical handling had taken nearly three hours to load.

E. G. Sturgess was the next speaker and he brought up the subject of the "Marketing Code". He felt that the "Marketing Code" represented a good first step, but that something more should be done in the way of helping to increase knowledge of the storage and handling of petroleum products among local authorities' licensing officers. Mr Colwell agreed that the present situation was unsatisfactory and he mentioned that he thought that there was a committee sitting at the moment to prepare something like a moral code for local authorities. Mr Treen confirmed this.

A vote of thanks to the speaker was proposed by A. T. Worcester.

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Books and Films

Proud Ships

This film tells the story of the ocean tankers which carry the petroleum industry's raw material and refined products from field to refinery and from refinery to user. Based upon the history of one Shell tanker, the *Liparus*, the viewer meets the master, his staff, and his crew and sees the operations of loading and discharging and the hazards of the battle with rough seas. The Shell Film Unit has done a worthy task in showing in the short time of 24 minutes the work of the tankers and their crews. In these stills are shown (*left*) how advantage is taken of unladen travel to inspect the tanks, (*left below*) a far from calm patch on the homeward voyage, and (*right below*) a lake tanker bringing a cargo of crude from Venezuela into Saint Amra Bay, Curacao, N.W.I.

The film (16 or 35 mm) is available on loan from the Petroleum Films Bureau in London or from Shell companies overseas.

BP News in Pictures

"The British Petroleum Company News in Pictures 1954" covers the operations of the Company and its associates during 1954. Among the events recorded are the settlement of the Iranian dispute, the coming on-stream of Aden refinery, and aspects of the Company's exploration work, such as the underwater search for oil off Abu Dhabi.

Copies of this booklet can be obtained from the General Department, The British Petroleum Co. Ltd., Britannic House, Finsbury Circus, London, E.C.2.

Corrosion Preventives

A new technical booklet produced by the Wakefield-Dick Industrial Lubricants Division of C. C. Wakefield and Co. Ltd. deals in some detail with corrosion, its causes, its cost, and the answer to the problem.

Sections are devoted to the causes of corrosion, the nature of temporary corrosion preventives, the application and removal of corrosion preventives, and typical applications. An abridged list of corrosion preventives is also included in the booklet.

German Chemical Books

Messrs Lange, Maxwell, and Springer Ltd. of London (242 Marylebone Road, N.W.1) and New York (122 East 55th Street, New York 22) have recently issued the second edition of their catalogue of German books on chemical and cognate subjects, 1950–53. The books are listed under subject headings and copies of the list, which has been prepared by A. E. Cummins and S. Vince, are obtainable from the addresses mentioned.

OCMC Specification

A new specification, No. Elec. 2, has been prepared by the Oil Companies Materials Committee for low voltage single phase transformer units used with portable hand-held electrical appliances (industrial).

The specification has been prepared by the Committee's Electrical Panel in order to unify the oil industry's requirements for such transformer units.

Copies of the specification can be obtained from the Oil Companies Materials Secretariat, Cecil Chambers, Room 525, Strand, London, W.C.2.

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World Oil Production Figures for 1954

According to estimates published by *Petroleum Press Service* crude oil production in 1954 was as much as 15 million tons, or 10·6 per cent, higher in the free countries of the Eastern Hemisphere (mainly in the Middle East) compared with 1953, but only 4 million tons, or less than one per cent, in the Western Hemisphere as a whole.

A decline of 6·4 million tons in U.S. output was more than compensated by increases in Venezuela, Canada, and Mexico and in virtually all other countries in the Western Hemisphere.

Middle East production in 1954 reached a record of nearly 136 million tons and it is noted that Saudi Arabia, with 46 million tons in 1954, is a close runner-up to Kuwait's 47 million tons. In Iraq, where production in 1951 was little more than 8 million tons, recent new pipelines and development of new fields have quadruped production to 31 million tons in 1954.

The accompanying table is reproduced by permission of *Petroleum Press Service* and gives details of estimates for all countries.

Discussing the prospect for 1955 in North America and Europe, the Petroleum Press Service states that demand for oil in the U.S.A. is expected to rise at a somewhat higher rate than it did in 1954, while there is no reason to expect any slackening in the rate of increase in Europe.

In addition, the increased investment and economic development likely to occur in under-developed countries is certain to raise the level of oil demand.

WORLD: ESTIMATED CRUDE OIL PRODUCTION

(Thousand metric tons)

	1952	1953	1954	1954 % Increase over 1953	1954 % of world total
North America					
U.S.A.: California	48,447	49,198	48,000		
E. of California	260,531	268,974	263,800		
	308,978	318,172	311,800	*dec.* 2·1	45·7
Canada	8,220	10,837	12,660	16·5	1·9
	317,198	329,009	324,460	*dec.* 1·2	47·6
Latin America—					
Caribbean Area					
Venezuela	94,626	92,261	97,400		
Colombia	5,432	5,507	5,750		
Trinidad	3,076	3,245	3,400		
	103,134	101,013	106,550	5·5	15·6
Other Countries					
Mexico	10,903	10,207	12,100		
Argentina	3,570	3,994	4,400		
Peru	2,176	2,107	2,250		
Ecuador	375	391	400		
Chile	116	164	230		
Bolivia	67	78	200		
Brazil	98	121	130		
Cuba	6	6	6		
	17,308	17,068	19,716	15·4	2·9
Middle East					
Kuwait	37,637	43,286	47,000		
Saudi Arabia	40,509	41,382	46,000		
Iraq	18,843	28,211	31,000		
Qatar	3,297	4,062	4,650		
Egypt	2,350	2,350	1,950		
Persia	1,040	1,322	3,000		
Bahrein	1,507	1,504	1,500		
Kuwait Neutral Zone	—	—	750		
Turkey	22	26	30		
	105,205	122,143	135,880	11·2	19·9
Far East					
Indonesia	8,524	10,225	10,500		
Br. Borneo	5,136	4,955	4,900		
W. New Guinea	288	262	550		
India	258	266	310		
Japan	294	290	300		
Pakistan	218	236	255		
Burma	130	156	180		
	14,848	16,390	16,995	3·6	2·5
European Area					
Germany	1,755	2,183	2,690		
Netherlands	715	820	900		
France	350	369	500		
Morocco Algeria	147	187	200		
Yugoslavia	152	171	225		
Italy	63	86	75		
U.K.	56	56	60		
	3,238	3,878	4,650	19·9	0·7
FREE WORLD					
Western Hemisphere	437,640	447,090	450,726	0·8	66·1
Eastern Hemisphere	123,291	142,411	157,525	10·6	23·1
TOTAL	560,931	589,501	608,251	3·1	89·2
Eastern Europe and China (*a*)					
U.S.S.R.	47,500	52,500	58,200		
Rumania	8,603	9,000	10,000		
Austria (Soviet Zone)	2,800	3,000	3,000		
Hungary	700	830	1,118		
Poland	235	190	190		
Albania	200	170	205		
Czechoslovakia	110	135	140		
China	140	200	400		
	60,285	66,025	73,253	10·9	10·8
WORLD TOTAL	621,216	655,526	681,504	3·9	100·0

(*a*) Where possible these figures are based on official indications or statements.

Oil Storage Experiment

At Wind Gap, Pennsylvania, a novel method of storing household heating oil is being used by the Esso Standard Oil Company, principal marketing and manufacturing affiliate of Standard Oil Company (New Jersey).

Oil is being stored in abandoned slate quarries to meet seasonal demands. By this means a large part of anticipated requirements can be manufactured during the summer and later combined with normal refinery production to meet winter demands, thus avoiding peak calls on refinery production and product transportation.

Esso Standard has purchased or holds under option nine

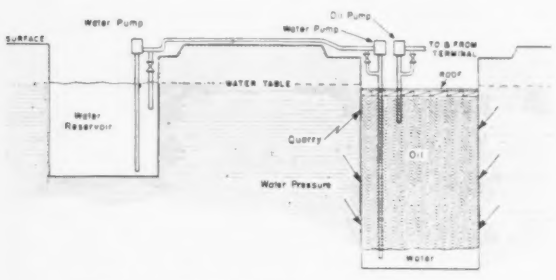

Fig 1. The principle of quarry storage.

quarries, six of which may be used for oil storage and three to act as the water reservoirs necessary to operate the scheme.

At present two quarries have been brought into use, Alpha, for oil storage, and Acme, a water reservoir. The surrounding area has been cleared of brush and trees and Alpha itself has been cleared of loose slate at its upper levels and perimeter.

Fig 1 shows in diagrammatic form how the system is put into practice. Oil is prevented from seeping through the walls of the quarry by the pressure of the surrounding water table which is always at least ten feet above the level of the oil. Any seepage must be in the direction of the quarry and as water is heavier than oil it will seep through the oil and settle under it. The ten-foot safety margin is more than ample to ensure proper sealing.

Alpha has a heating oil storage capacity of 42 million gallons. It measures 250 by 350 ft and ranges up to 225 ft deep. The quarry plus Acme reservoir and the surrounding area covers about five acres in all. The same quantity of oil stored in tanks at a refinery would require approximately seven tanks and 14 acres of land. It would also entail the use of at least ten times the amount of steel.

Alpha is connected to the Bayway refinery at Linden, New Jersey, about 65 miles away, by a six-inch pipeline. Oil will enter the pit at about 250 thousand gallons a day during the summer and will be withdrawn to the refinery for distribution at about 400 thousand gallons a day during the peak demand season.

As oil is pumped into the quarry water will be withdrawn from the bottom and when oil is withdrawn the procedure will be reversed and water will be pumped in. Constant supervision will be required only when filling or emptying is being carried out, at other times caretaker supervision will be sufficient.

Alpha is protected by a steel pontoon roof, constructed to float directly on the surface of the oil, which covers the 56,000-square-foot opening and prevents airborne contamination, evaporation, and the deleterious effects of direct sunlight.

The roof is made up of some 240 box-like sections of steel. The pontoons measure 32 ft long, 7½ ft wide, and 1 ft deep. Each weighs approximately 2¼ tons. These sections are welded together to form one large pontoon. Small areas created by the irregularity of the quarry walls are covered by specially shaped sections and a neoprene apron, hanging from a shelf following the contour of the walls, is attached to the roof to cover areas where the roof is not flush with the sides of the quarry.

Cables with coil springs in the centre are anchored to the quarry wall and the roof to keep the roof centred in the pit.

This is the first time that abandoned quarries have been used for this purpose in the U.S.A. and this ingenious plan has released a vast amount of potential storage space, space which is additionally attractive in that it is removed from the congestion of the industrial areas.

Esso Standard does not itself at present intend to convert other quarries in this way until this is warranted by an increased demand for heating oil and until time has elapsed in which to judge the success of the Alpha-Acme venture.

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OEEC Chemical Conference

"The Functions and Education of the Chemical Engineer in Europe" is the title of a conference to be held under the auspices of the Organization for European Economic Co-operation from 21 to 23 March this year.

The conference is being organized on behalf of OEEC by the Institution of Chemical Engineers in conjunction with the Department of Scientific and Industrial Research. It is to be held at Church House, Westminster and eleven Western European countries are expected to take part.

The object of the Conference is to draw attention to three main requirements in Europe in the rapidly growing field of chemical engineering:—

(*a*) The necessity for more chemical engineers and more schools of chemical engineering.

(*b*) The necessity for more financial aid for chemical engineering research.

(*c*) The necessity for a more general recognition of the part that chemical engineering is playing in modern industry.

Papers will be presented by delegates from various European countries.

Details of registration and the programme of the Conference can be obtained from The Secretary of the Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1.

Notes of the Month

Christmas Lectures on Petroleum

A series of six Christmas Juvenile lectures was delivered at the Royal Institution at Christmastime by Sir Frank Whittle, K.B.E. The theme of the lectures was "The Story of Petroleum" and Sir Frank dealt with the uses of petroleum,

Sir Frank Whittle in a space helmet and Miss Vergette, a model who was dressed entirely in petroleum products.

petroleum geology, exploration, production, and transportation, power from petroleum, refining of petroleum, and gas turbines and the oil industry.

Sir Frank spoke before large audiences of adults and children and used many working models and specimens to illustrate his talks.

The Christmas Juvenile lectures were inaugurated by Faraday in 1826 and are designed to promote scientific interest in the youthful mind.

Floods in Kuwait

Twenty thousand people were rendered homeless in Kuwait town after widespread flooding in Kuwait at the end of last year. A rainfall of almost five inches was recorded during the last ten days of November and this caused loss of life and interruption of communications.

Damage was especially severe to mud brick houses in the older parts of Kuwait town and the State authorities now propose to issue regulations requiring the use of red brick and cement materials in building houses in future.

Fortunately, very little damage occurred to the installations of the Kuwait Oil Company and the Company's personnel were able to help in the relief operations. Meals were provided for 750 homeless people in neighbouring villages for about two weeks until the State relief organizations could undertake to feed them.

BP Special Energol

A new "multi bracket" motor oil, for use in place of SAE 10W to 40 grades of oil, is now being marketed in the U.K. by Shell-Mex and B.P. Ltd. under the name of BP Special Energol Visco-Static Motor Oil. It is recommended for all four-stroke petrol engines in good mechanical condition.

The new oil has been produced as the result of an extensive programme of research carried out at The British Petroleum Company's research station at Sunbury-on-Thames.

Impressive results have been obtained with the new oil under test and an 80 per cent reduction in over-all engine wear is claimed as a result of the oil's special visco-static and detergent properties. In particular, the oil offers protection against corrosion while the engine is stationary and greatly reduces the rate of wear when starting from cold.

This is an all-seasons oil and a reduction in petrol and oil consumption, together with a lessening of battery strain, are also said to result from its use.

Woodstock Extensions

By April this year all agricultural research undertaken by the Shell Petroleum Co. Ltd. in the U.K. and Holland will be centred at Woodstock Farm, near Sittingbourne, Kent.

Extensions costing £150,000 are in process of being carried out and these will enable synthesizing and analysing of new chemicals to be undertaken as well as testing. It is proposed to increase the number of staff at the research station from 32 to 100.

New buildings at Woodstock will include three laboratories, an administration block, an engineering workshop, and two glass houses. Included in the new laboratories will be separate departments for research on insecticides, fungicides, and herbicides, and for chemical synthesis and analysis of new products.

Woodstock is run as a farm and of its 254 acres 170 produce cereals, hops, and fruit.

In the U.S.A. Shell's agricultural research is carried out at Modesto, California, and Denver, Colorado.

Kwinana's First Tanker

Early in January the first cargo of crude oil was brought to British Petroleum's Kwinana refinery, near Fremantle, Western Australia, in the 16,000-dwt tanker *British Crusader*.

Arrival of the *British Crusader* marked the opening to large-scale shipping of Cockburn Sound on which the new refinery stands. In honour of the occasion many Australian dignitaries were present on board the tanker and escorting vessels, and the tanker cut a tape stretched between beacons at the entrance to the dredged channels.

BP Canadian Interests

British Petroleum's D'Arcy Exploration Co. is to increase to 50 per cent its holding in the Triad Oil Co. Ltd. of Calgary, Canada.

In doing so D'Arcy has taken up an option dating from October 1953 when it first acquired an interest in Triad equal to approximately 23 per cent.

This later transaction will eventually increase D'Arcy's investment in Triad to some £7,000,000.

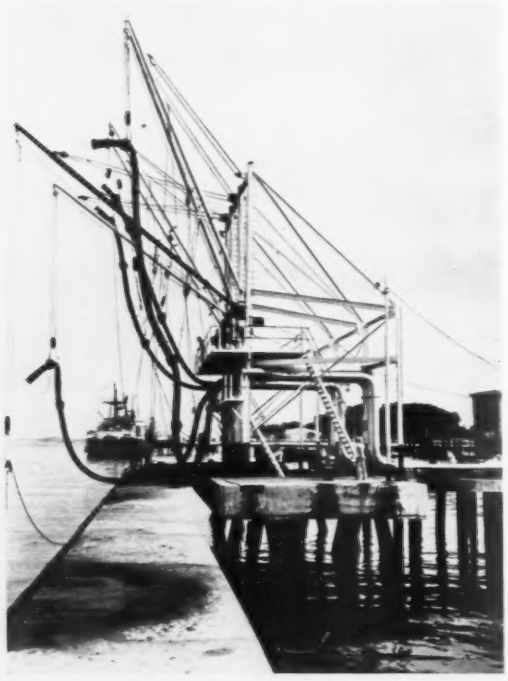
New Oil Berths at Singapore

Four new oil berths, capable of accommodating super tankers of up to 60,000-tons displacement, are being built at Shell's marine installation at Pulo Bukom, Singapore, at a cost of £500,000. Unique methods of construction are being used in three of the berths and new shore facilities are also being provided which will allow landing and discharge rates of 1000 to 1500 tons per hour. Modern hose handling gear is also being installed.

The wharves were designed by Sir William Halcrow and Partners, consulting engineers, who also supervised the work of construction. Messrs Gammon (Malaya) Ltd. carried out the construction work.

The difficulty in constructing the four new berths was to provide a structure capable of absorbing the kinetic energy of vessels of up to 60,000 tons displacement when berthing at speeds which, it was estimated for the prevailing conditions, might be of the order of 9 to 12 inches per second. The structures had to be constructed in deep water and the problem was further complicated by the steeply shelving sea bed.

Two solutions were finally evolved. The first of these is represented by the dolphins constructed at one of the four



A Shell photo

Hose handling gear on one of the wharves.

wharves, the design of which was adapted from similar structures already existing at the Shell Installations at Pernis, Holland. The dolphins consist of a number of high tensile steel piles driven deep into the sea bed, braced together at their upper ends and finished with a "rubbing face" of heavy timbers. The dolphins are "flexible" and absorb the energy of impact by bending. This type of structure can be built comparatively quickly and was selected primarily on that account, although as a berth it suffers from the drawback of offering only two small isolated berthing faces to the approaching vessel, and also because the working area of the jetty head has to be set back 13 feet from the berthing face.

The second type of structure was adopted for the other three wharves and consists in each case of a heavy reinforced concrete beam 240 feet long carried on a single line of forward raking high tensile steel piles. A novel feature of the design was the arrangement whereby the casting of the concrete beam, which is heavily reinforced and weighs approximately 1100 tons, gave the line of piles an initial forward deflection—in effect a pre-stress—which enhanced their capacity to absorb by pile bending, although the mathematical analysis of these breasting beams is somewhat more complex than that of the dolphins. As far as is known these structures are unique.

In each case the wharf was completed by the construction of an independent jetty head, carrying hose handling gear, deck houses and the like, together with an approach jetty and pipe gantry. The jetty heads consist of solid reinforced concrete slabs carried on raking steel piles, whilst the approaches are of reinforced concrete throughout, neither having any unusual features of design or construction. Mooring dolphins of mass concrete on steel piles were also provided, to resist pulls in mooring ropes up to 120 tons.

New Oilfield in Iraq

Oil from a new field in Rumaila in southern Iraq is now supplementing the crude oil resources of the Basrah Petroleum Co. Ltd.

The full extent of the new field is not yet known but it is being developed and it is hoped that output will compensate for the recent rather rapid pressure decline in the Company's Zubair field. Rumaila is situated twenty miles west of the Zubair field and is linked to it by a 12-inch-diameter surface pipeline which was laid during 1954.

Drilling was first begun at Rumaila early in 1953 and five wells have now been completed for production. In addition three other wells are in process of being drilled.

In November last year a degassing station was brought into commission and a pump-house has also been built to pump oil from Rumaila to the main pump-house at Zubair. From there crude oil from the two fields flows down a 24-inch and 12-inch pipeline system to Fao Terminal on the banks of the Shatt al Arab.

The European Chemical Industry

Production in the European chemical industry has increased during the period 1951–53 at a substantially higher rate than the average for European industry as a whole.

This information is contained in a report published recently by the Chemical Products Committee of the OEEC entitled the "Situation in the European Chemical Industry".

Progress figures since 1950 are Italy 57 per cent, Germany 43 per cent, Belgium 22 per cent, and U.K. 20 per cent. This trend must however be related to the world situation which has greatly changed since before the last war. At that time production in OEEC countries represented about 50 per cent of world production, but in 1951 it fell to about 25 per cent, while U.S. production, which before the war accounted for 30 per cent of world production, rose to 40 per cent in 1951.

Development has not been uniform throughout the industry and the report emphasizes that the output of basic and intermediate products and of certain end-products such as plastics and synthetic detergents has expanded considerably, whereas other products have remained stationary or declined.

Attention is drawn in the report to the growing importance of the petroleum chemical industry as a source of basic chemicals for the manufacture of new products such as plastics, synthetic detergents, etc. Investment in the petroleum chemical industry rose from $240 million in 1953 to $260 million in 1954, an increase of about 8 per cent, and it is expected to increase by about 80 per cent by 1957.

Iraq Orders New Insecticide

Endrin—a new Shell insecticide—is to be used by the Iraq Government to control the spiny bollworm—a dangerous pest which is attacking Iraq's cotton crop.

A £20,000 order for endrin has been placed as a result of comparative field experiments with a number of insecticides carried out by the Iraq Ministry of Agriculture and an American entomologist working under the auspices of the Food and Agriculture Organization of the United Nations.

The spiny bollworm is a major cotton pest problem in Middle East countries such as Iraq, Syria, Iran, and Jordan, which have recently started to grow cotton, and Iraq's experiments with endrin may be of general importance in the cotton growing policy of these countries.

Endrin is at present produced only in the U.S.A. but to meet the increasing demand Shell is planning to manufacture endrin at the chemical insecticide plant at Pernis refinery, Rotterdam. Output is expected to commence by the middle of 1956.

Haile Selassie Visits Laboratories

During his State visit to Britain at the end of last year, His Imperial Majesty, Haile Selassie, Emperor of Ethiopia, paid a visit to the laboratories of Hunting Aero-surveys Ltd. at Boreham Wood. The Emperor was met by P. Ll. Hunting, chairman of the Hunting Group of Companies, and F. L. Willis, managing director.

During a conducted tour of the works His Imperial Majesty watched British technicians at work on mapping and interpretation from aerial photographs.

The photograph shows the Emperor entering an aircraft hanger at Elstree aerodrome with one of the Company's pilots.

Experiment in Road Tanker Construction

Glass-reinforced polyester resin has been used for a fuel bunker tank and fitments on a road tanker owned by Shell-Mex and B.P. Ltd. The tanker was fitted with a 40-gallon fuel bunker tank, a product delivery pipe, and a pair of mudguards of this material, in an experiment to find out whether it is possible to put on the road bigger tankers with greater load-carrying capacity.

Shell-Mex and B.P. Ltd. is conducting the experiment in conjunction with Semtex Ltd., a Dunlop subsidiary.

The new material which is being used combines lightness, strength, and anti-corrosive properties. Tankers made from it are already being produced in the U.S.A. The aim of the present experiments is to study the material under normal vehicle operating conditions to assess the possibilities of increased payloads. Effects of exposure to diesel oil and the product carried, and also any flow effects, must be studied. The effect of vibration is also to be considered further.

One important virtue of the new material is the speed with which repairs can be carried out to a fitment *in situ* on the vehicle.

U.S. Natural Gas Production

Total natural gas production in the U.S.A. in 1953 was 10,645,798 million cubic feet, an increase of 373,232 over 1952. Of the total production, 8,396,916 million cubic feet were marketed, 1,438,606 used for repressuring, and 810,276 vented and wasted. Utilization of marketed production in million cubic feet was: residential, 1,685,503; commercial, 530,650; field (drilling, pumping, etc.), 1,471,085; fuel at petroleum refineries, 558,695; other industrial, 3,733,405.

ASTM Mass Spectrometry Conference

The Third Annual Conference on Mass Spectrometry sponsored by ASTM Committee E-14 will be held in San Francisco, California, from 23 to 27 May this year.

The programme will consist of papers covering all aspects of the theory and application of mass spectrometry. Papers are invited and titles should be submitted by 15 February 1955 to W. Priestley, Jr., Standard Oil Development Co., Box 121, Linden, New Jersey.

An exhibition of mass spectrometry equipment will be held in conjunction with this meeting and exhibitors are invited to obtain more information from Dr J. G. Hutton, General Electric Co., 1 River Road, Schenectady, New York.

Platforming Catalyst Manufactured in U.K.

UOP platforming catalyst is now being manufactured for the first time outside the U.S.A. at the newly-opened plant of Universal-Matthey Products Ltd.

The plant, which was built by Procon (Great Britain) Ltd., was opened last November and will supply customers in England, Germany, France, Australia, and Aden.

Universal-Matthey is a subsidiary of Universal Oil Products Company, Des Plaines, Illinois, developers of the UOP platforming process, and Johnson, Matthey and Co. Ltd., London platinum refiners.

Addition to Shell X-100 Range

A new grade of motor oil with special viscosity characteristics has been added to the range of Shell X-100 motor oils. At starting temperatures the new oil, Shell X-100 10W-30; is said to have the viscosity of an X-100 10W oil, while when the engine is hot the oil is as thick as a normal summer grade X-100 30.

Special qualities of the new oil have been achieved by blending the normal components of Shell X-100 motor oil with certain oil-soluble polymerized organic compounds.

The new oil should obviate the need to make seasonal changes of grade in most cars and is recommended for engines normally using oils of SAE grade 10W to 30 inclusive.

International Congress on Catalysis in 1956

An International Congress on Catalysis is to be held in Philadelphia from 10 to 14 September 1956. It will be sponsored jointly by The National Science Foundation, The Catalysis Club of Philadelphia, The Catalysis Club of Chicago, and the University of Pennsylvania. This will be the first international meeting on catalysis to be held in America.

The National Science Foundation has given a grant to the sponsors of the Congress to enable them to offer some financial support to scientists who could not otherwise attend the meeting. Additional funds are being raised by subscription. All inquiries concerning this meeting and its organization should be directed to Dr H. Heinemann, executive secretary of the International Congress on Catalysis, c/o Houdry Process Corporation, P.O. Box 427, Marcus Hook, Pennsylvania.

Members of the Council of British Manufacturers of Petroleum Equipment visiting the Industrial Applications Centre of Philips Electrical Ltd.

The group pictured above was being shown a Philips combined magnetic-mechanical filter.

Centre front, examining the filter, is Mr C. E. R. Sams.

Vacuum Oil Co. Ltd.

As a consequence of the recent transfer of the Powell Duffryn Group shareholding in Vacuum Oil Company Ltd. to Socony-Vacuum Oil Company Inc. of New York, the five directors originally nominated by the Powell Duffryn Group, namely Sir Herbert Merrett, Sir Henry Wilson Smith, W. M. Codrington, Miles B. Reid, and H. V. Vale, have resigned from the Board of Vacuum Oil Company Ltd.

The Company is now a wholly-owned subsidiary of Socony-Vacuum. On the invitation of that Company, Sir Henry Wilson Smith and Miles B. Reid have been re-elected to the Board of Vacuum Oil Company Ltd., which now consists of: J. C. Gridley, C.B.E. (chairman), H. W. Rocke (managing director), C. Lawrie, J. Blake Middleton, Miles B. Reid, M.B.E., M.C., J.P., Sir Henry Wilson Smith, K.C.B., K.B.E. and J. S. Vesey Brown.

Change of Name

With effect from 1 December last year the French Société Générale des Huiles de Pétrole BP has changed its name to Société Française des Pétroles BP.

The French company, which is an association of The British Petroleum Co. Ltd. with its French interests, has a refinery capacity of over four million tons a year.

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Forthcoming Meetings

THE INSTITUTE

(At 26 Portland Place, London, W.1, 5.30 p.m.—tea 5 p.m.)

Applicational Research in the Petroleum Industry. C. G. Williams, D.Sc., M.I.Mech.E., F.R.Ae.S. **9 February**

The Modern Planning of Regional Surveys for Petroleum. P. Leicester, B.A. **21 February**

Annual Dinner. Grosvenor House. 6.45 for 7.30 p.m. **23 February**

The Viscosity of Liquid Hydrocarbons. L. Grunberg, M.Sc., A.R.I.C., A.M.I.Chem.E., F.Inst.Pet. **9 March**

IP FAWLEY BRANCH

(At Esso (Fawley) Recreation Club, Holbury, 7.30 p.m.)

Detergents from Petroleum. Dr S. F. Birch, A.R.I.C.S., D.I.C. **18 February**

The Oil Industry in World Economy. M. E. Hubbard, B.A., M.I.Mech.E. **18 March**

IP LONDON BRANCH

(At 26 Portland Place, London, W.1, 6 p.m.—tea 5.30 p.m.)

Additives—their Functions Explained. N. E. F. Hitchcock, B.Sc. **2 March**

The Manufacture and Use of White Oils and Sulphonates. T. F. Brown, Ph.D., A.R.T.C., A.M.I.Chem.E., F.R.I.C. **22 March**

IP NORTHERN BRANCH

(At Engineers' Club, Albert Square, Manchester 2, 6.30 p.m.)

Some Developments in Fuels and Lubricants for Jet Engines. C. J. O. Moorhouse. 6.30 p.m. **15 February**

Symposium on the Lubrication of Transport Fleets. Chairman: A. T. Wilford, B.Sc., F.R.I.C., M.I.Mech.E. **15 March**

IP SOUTH-EASTERN BRANCH

(At King's Head Hotel, Rochester, 7.45 p.m.)

Packing Materials and Face Seals. S. C. W. Wilkinson and S. C. Weston **7 March**

IP STANLOW BRANCH

(At the Grosvenor Hotel, Chester, 7.30 p.m.)

Relations between the Petroleum Industry and Government. V. Butler, C.M.G. **16 February**

The Polymerization of Sulphur. Prof. G. Gee, F.R.S. **3 March**

Platforming. **16 March**

ECONOMICS AND OPERATIONS GROUP

(At 26 Portland Place, London, W.1, 5.30 p.m.—tea 5 p.m.)

Symposium on Public Opinion and the Oil Industry. **1 March**

OTHER SOCIETIES

A Study on the Significance of the Bitumen Ductility Test. Dr R. N. J. Saal. Society of Chemical Industry, Road and Building Materials Group, Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1. 6 p.m. **17 February**

Pilot Plant and Scale-up Problems. The Institution of Chemical Engineers, North Western Branch, Manchester. The College of Technology. 2.30 p.m. **12 March**

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THE ARCHAEOPTERYX*

Addressing the Zoological Section of the British Association at Oxford recently, Sir Gavin R. de Beer, F.R.S. (sectional president) chose for his subject "Archaeopteryx and evolution". He described the fossil *Archaeopteryx lithographica* as the most precious, the most beautiful, and the most interesting fossil hitherto discovered. Since it was described over 90 years ago by Richard Owen, a few contributions to knowledge of it had been made and Sir Gavin gave results of his investigations with modern methods.

With the use of the ultra-violet technique a number of important discoveries had been made and it was clear that *Archaeopteryx* provided "a magnificent example of an animal intermediate between the reptiles and the birds, sharing with each a number of well-marked characters."

If the method of transition from reptiles to birds, as shown in *Archaeopteryx*, were of general applicability, it should be possible by direct appeal to the facts of observation to demonstrate its occurrence in the case of other great transitions, from fish to amphibia, from amphibia to reptiles, and from reptiles to mammals. In each case fossils were known which, although not themselves the direct ancestors of the remainder of the animals in the shelf to which the evolution was progressing, were nevertheless so closely related to them that they could be taken as examples of animals in transition.

*The Archaeopteryx is the basis of the IP crest.

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SITUATIONS VACANT

Air Ministry require in London designer draughtsmen for bulk petroleum storage and pumping installations experienced in one or more of following:—(*a*) storage tank layout and design, (*b*) pump-house and plant layout, (*c*) development of pipeline scheme, (*d*) hydraulic calculations. Technical training to O.N.C. standard required. Salaries up to £695 p.a. starting pay based on age, qualifications, and experience. Overtime payable. Promotion prospects, and long term possibilities. Natural born British subjects only. Write stating age, qualifications, employment details, including type of work done, to Ministry of Labour, 236 Walworth Road, London, S.W.17, quoting Order 3593.

Esso Petroleum Company Limited, Refinery Department, Fawley, Southampton, have the following staff vacancies:—(1) **Chemical Engineers and Chemists** for technical service and development work involving distillation, cracking, chemical treating, and experimental laboratory. Candidates should have a good degree, and experience in the Petroleum or Allied Industries would be an advantage. Experience with Bitumen products or Catalyst would also be of interest. (2) **Graduate** with good degree in Chemical Engineering or Chemistry with qualifications or experience in Economics required for a technical group dealing with economic study work on Refinery operation. (3) **Graduate** with good degree in Mathematics, preferably with qualifications or experience in Chemistry or Chemical Engineering, required for work on statistical analysis and electronic computer studies. (4) **Mechanical Engineer** for technical advisory work in connexion with operating problems on compressors and pumps. A good degree in Mechanical Engineering or an A.M.I.Mech.E. is essential and experience in the Petroleum or Allied Industries would be an advantage. The successful candidates will work as members of a team in a technical advisory department. All the above are regular posts, with salaries ranging from the £600's for suitable newly-qualified graduates up to four figure salaries for candidates with relevant industrial experience. There is an excellent and comprehensive Pension Scheme: recreational facilities of all descriptions are available in a pleasant rural area bordering Southampton Water. Applications should be sent in writing to Employee Relations Superintendent at the above address, giving, in confidence, details of age, qualifications, experience, availability, present salary, and salary required.

"When I die, my sons," said the old Arab sheik, "you, Ibrahim, will receive half of my property. You, Abdul, will receive one-third, and little Omar, one-ninth".

When their father died, the brothers were embarrassed to find that the property consisted of seventeen camels. However, a friend of their father helped them to solve the problem by lending them yet another camel, with the result that Ibrahim now owns nine healthy camels, Abdul is very proud of his six, and little Omar cannot decide which of his two he likes the better.

And the eighteenth camel?—it was returned to their father's friend. It had made the distribution possible, but yet remained quite unaffected itself—just as a catalyst will speed up a chemical reaction without being affected in any way itself.

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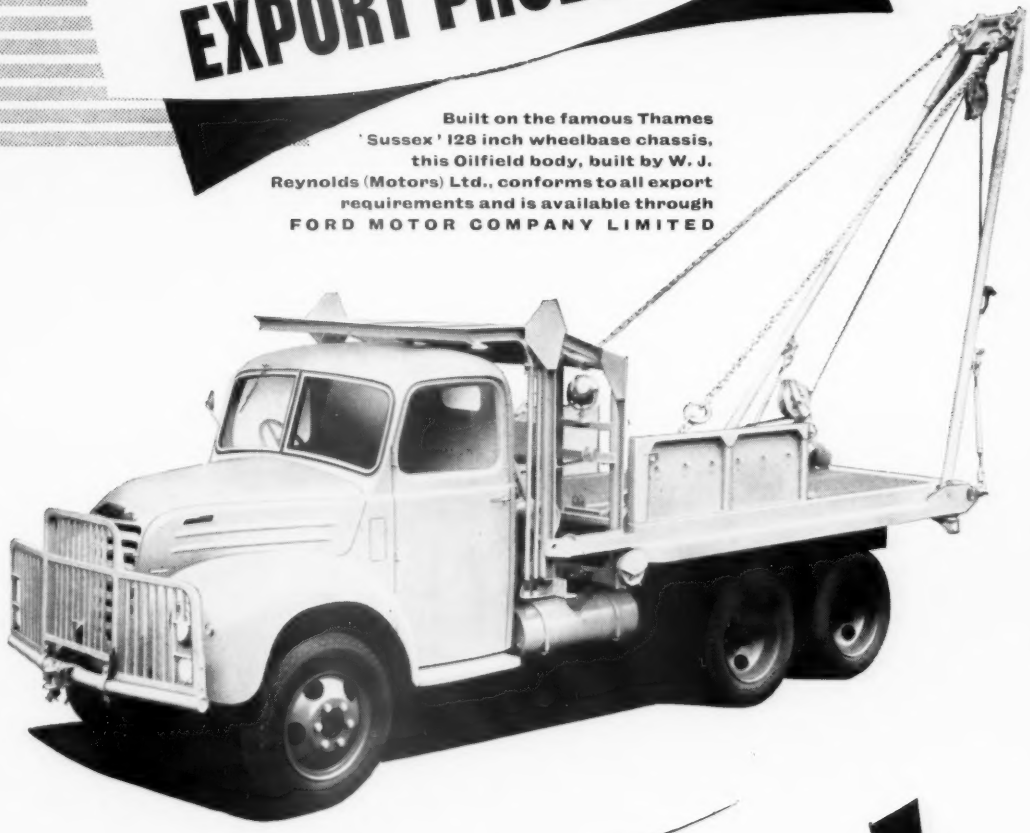

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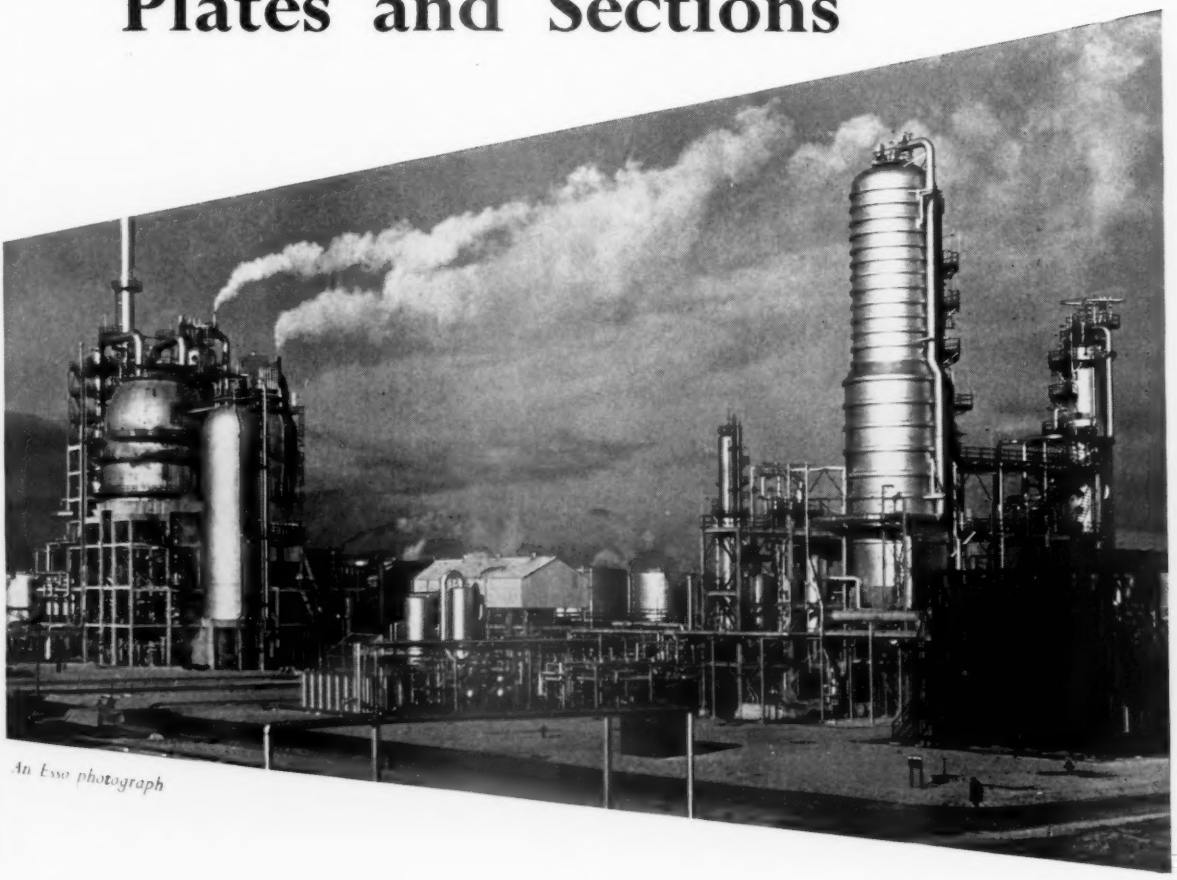

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The modern trend towards miniaturisation in industrial control equipment has led to the design and development of the Evershed Miniature Recorder. Illustrated below is a Control Desk recently supplied to the Grangemouth Refinery of Scottish Oils Ltd., on which 38 recorders are fitted. They have also been supplied for the new Anglo-Iranian Refinery at Aden.

The Evershed Miniature Recorder has the maximum self-contained ranges of 500 v. or 10 amperes and will prove to be of great use to engineers and designers throughout industry. It is suitable for either flush or surface mounting or can, by the use of a leather sling, be used as a portable instrument.

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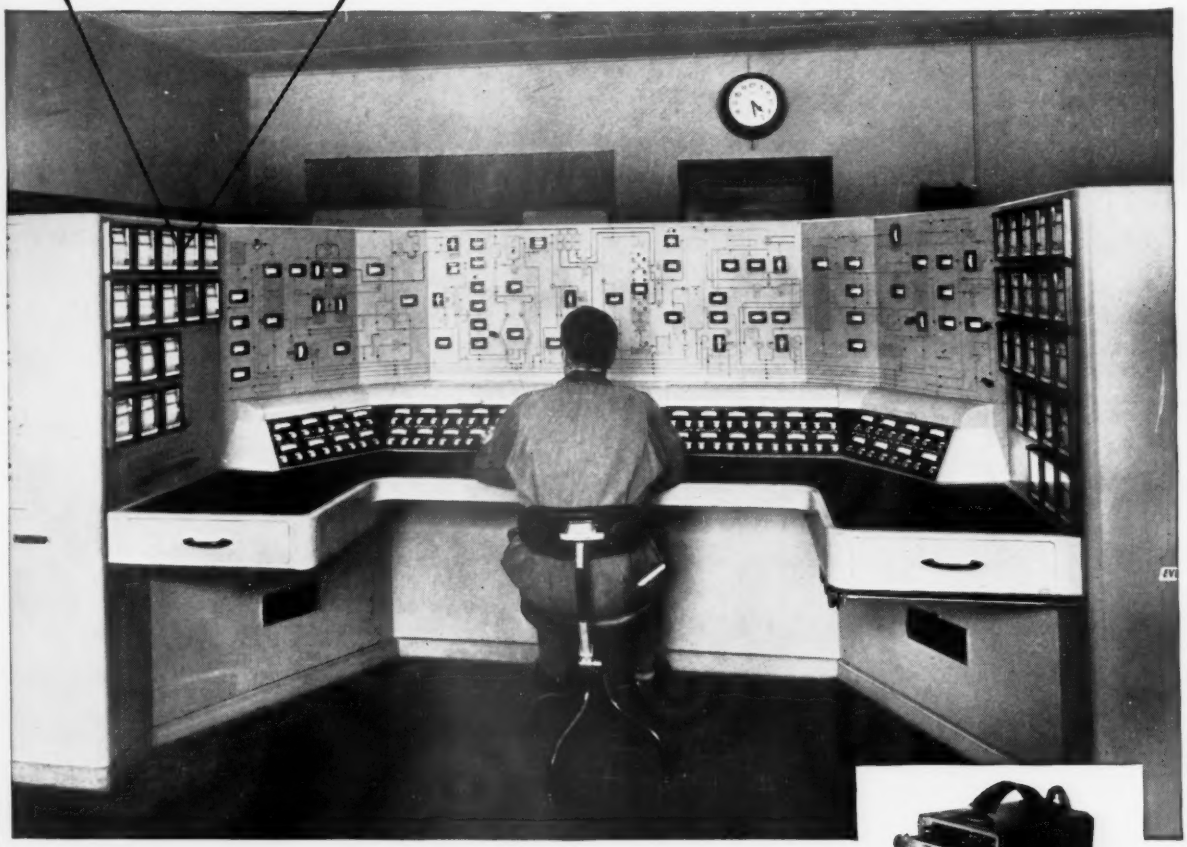

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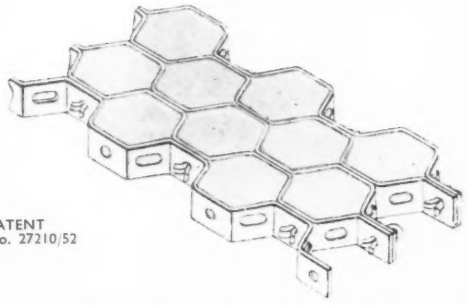

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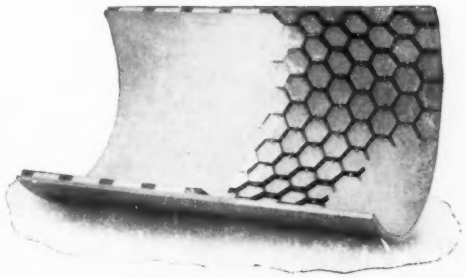

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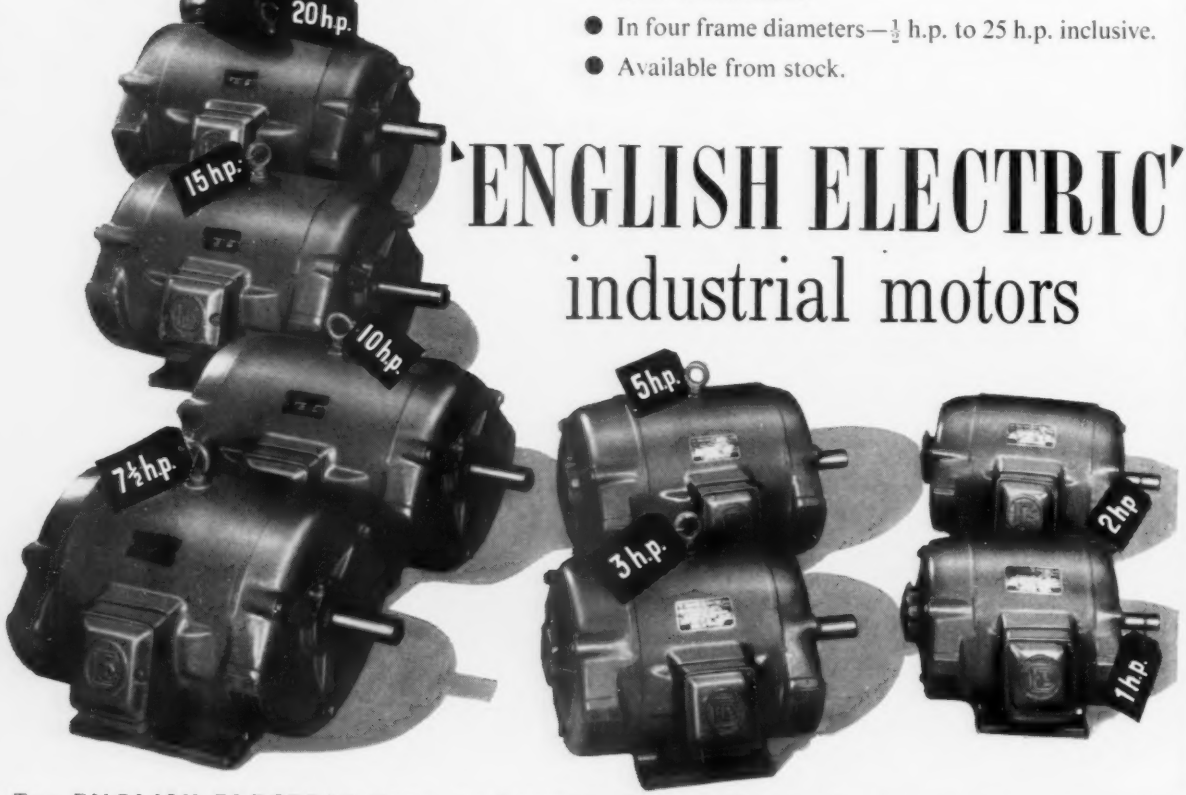

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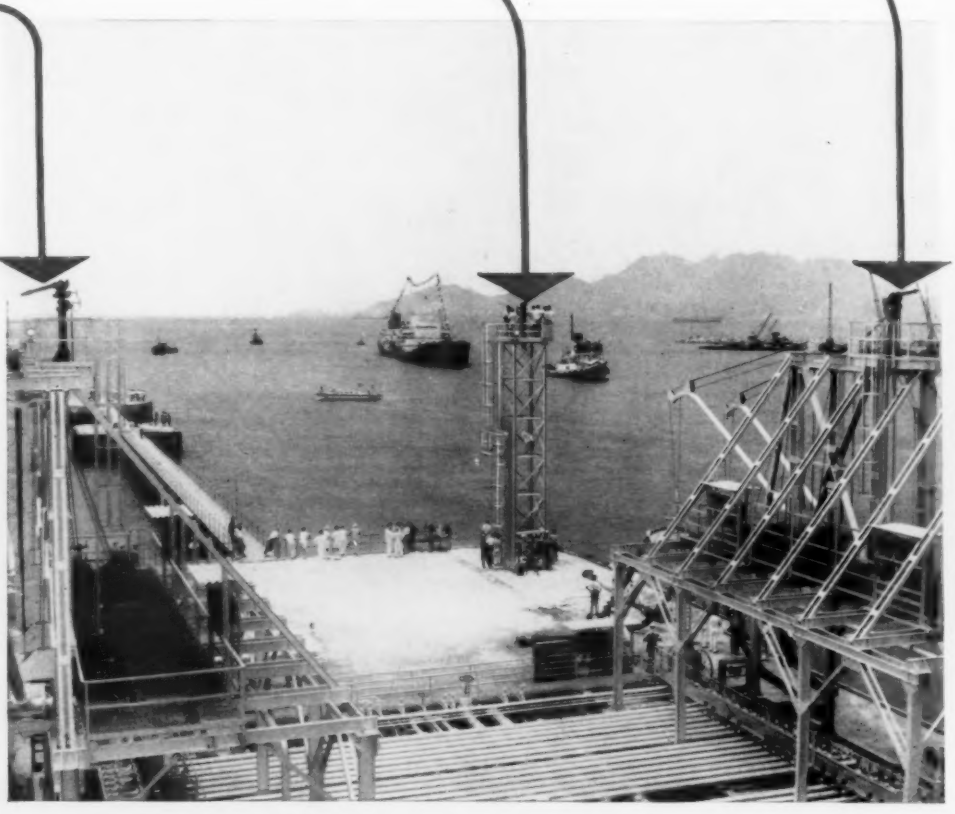
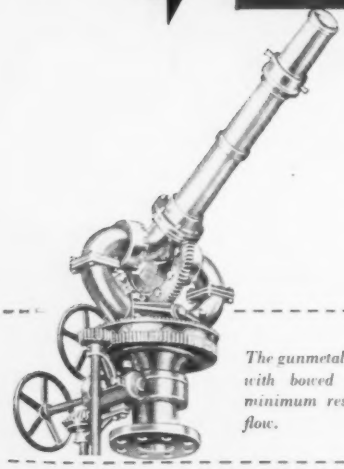


Foamite JETTY MONITORS



Standing fire guard along the jetty at Aden are the familiar Foamite Foam Monitors mounted on steel towers. Altogether there are 12 of these monitors in this installation spaced at strategic intervals. Three can be seen in the photograph taken on the occasion of the arrival of the first tanker in the harbour.

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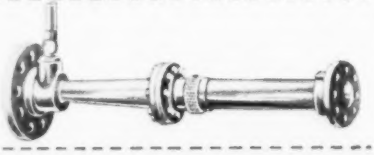
Photograph by courtesy of The British Petroleum Co. Ltd.

The gunmetal monitor is 4" size with bowed shoulders giving minimum resistance to liquid flow.

Pressure Foam Maker comprising Proportioner (mixing water and air foam liquid) and Aspirator (aerating the mixture)



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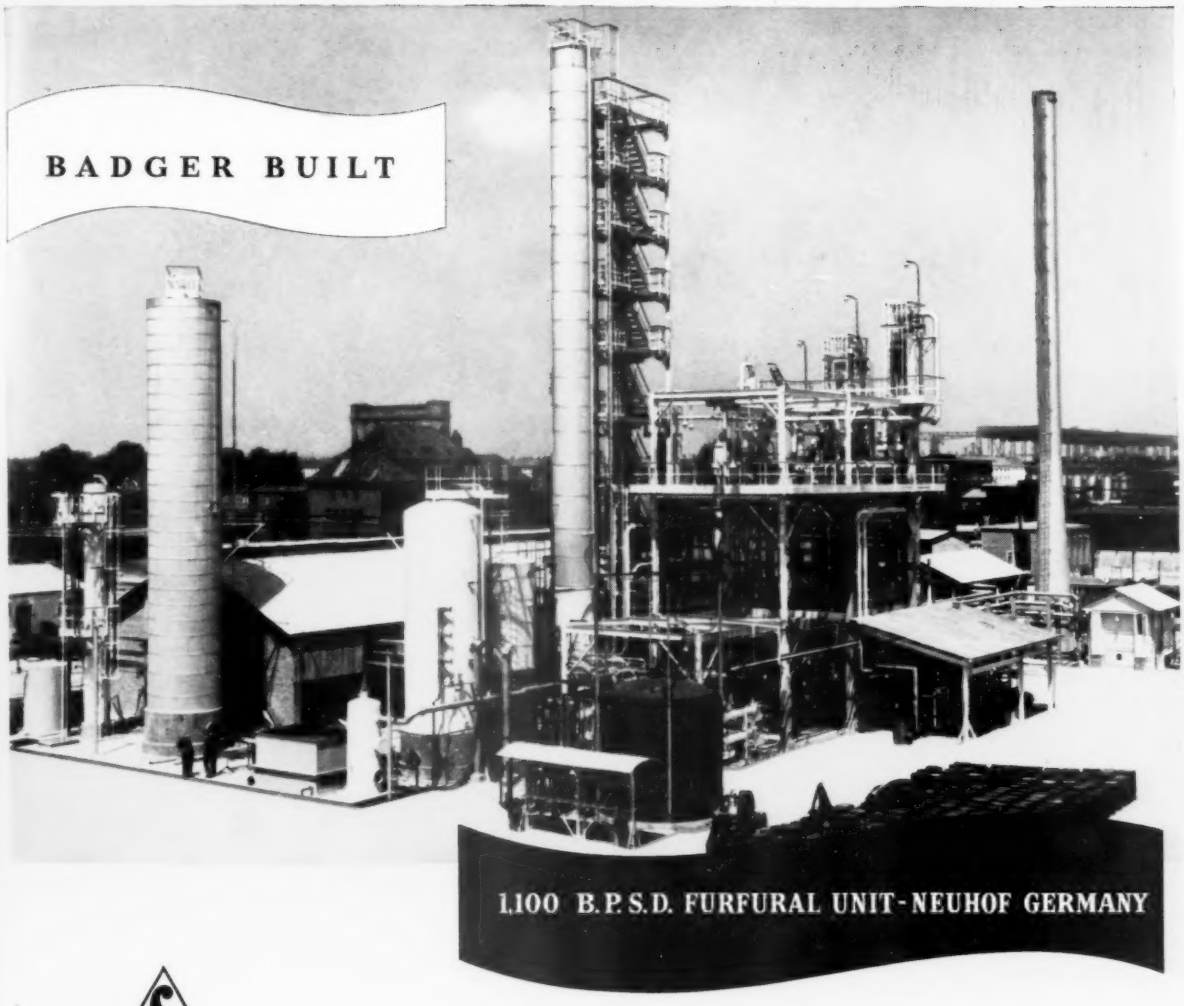

Completed in 1954, this furfural extraction unit is a part of the lubricating oil refining facilities of Oelwerke Julius Schindler, G.m.b.H., a German affiliate of the British Petroleum Company Limited. Badger's services in connection with this plant included its design and procurement and supervision of the erection.

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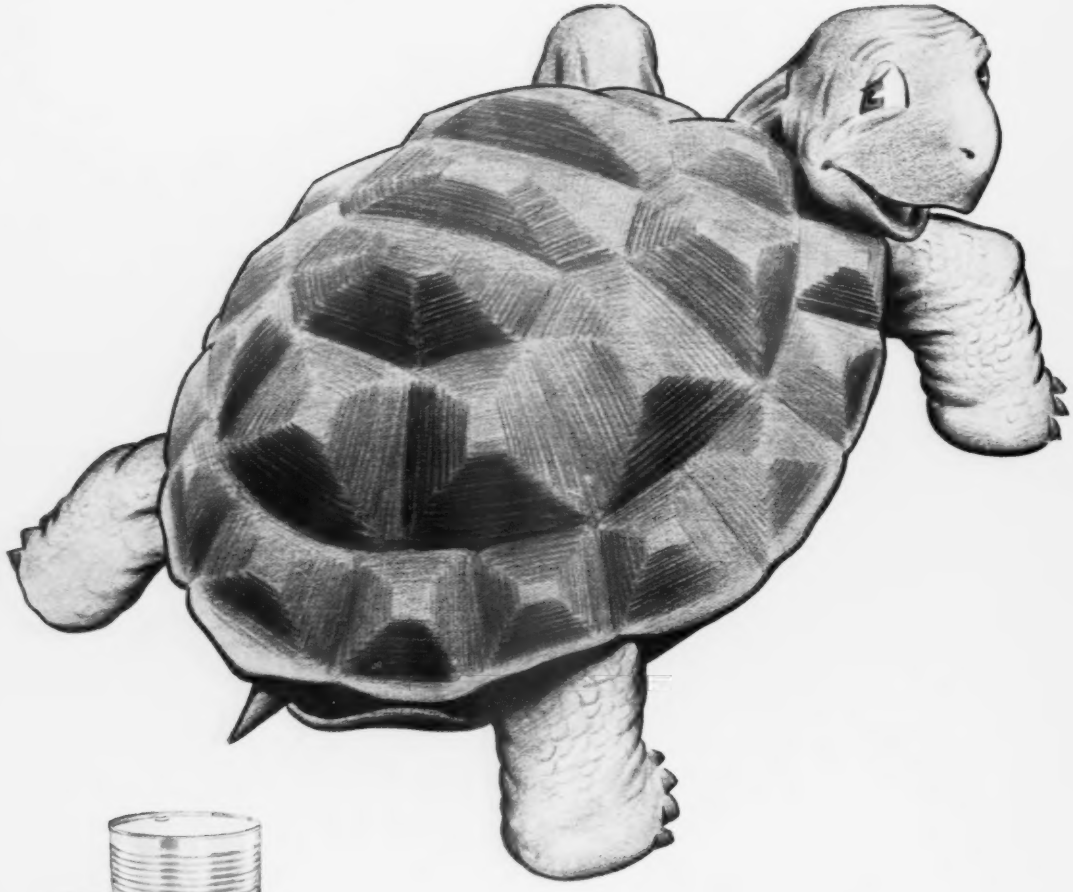

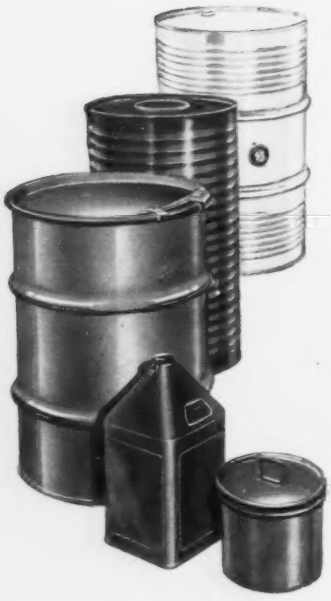

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